MACHINE DESIGN

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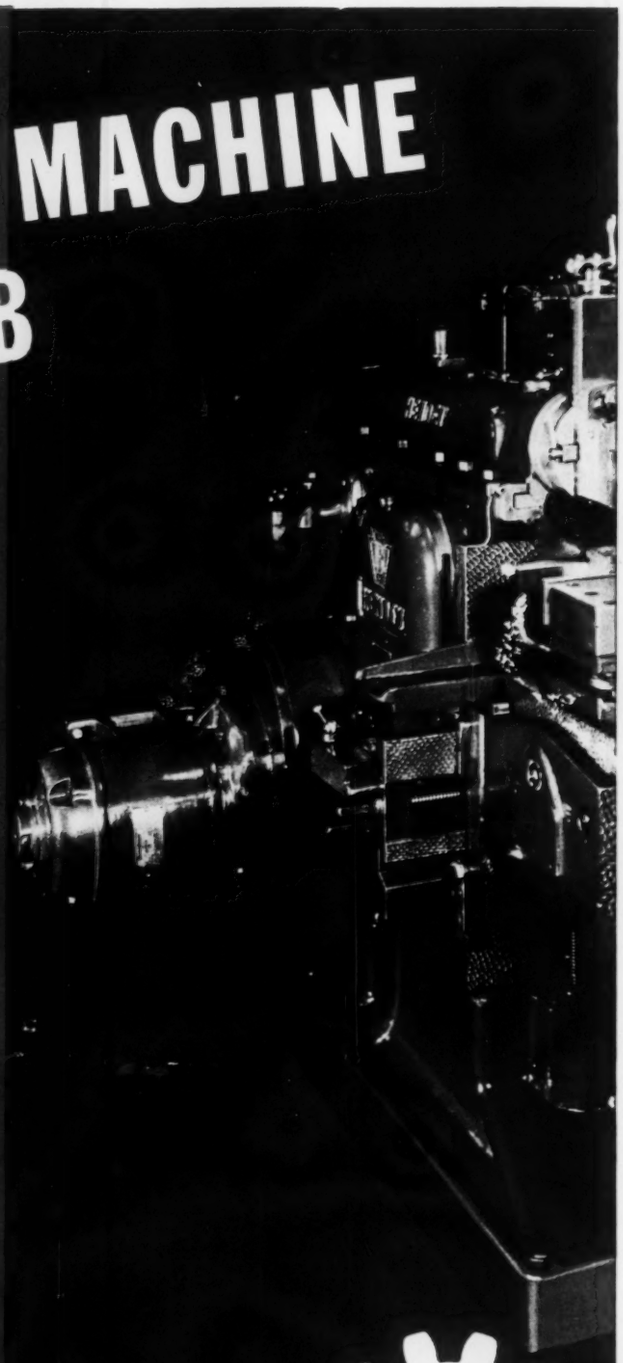

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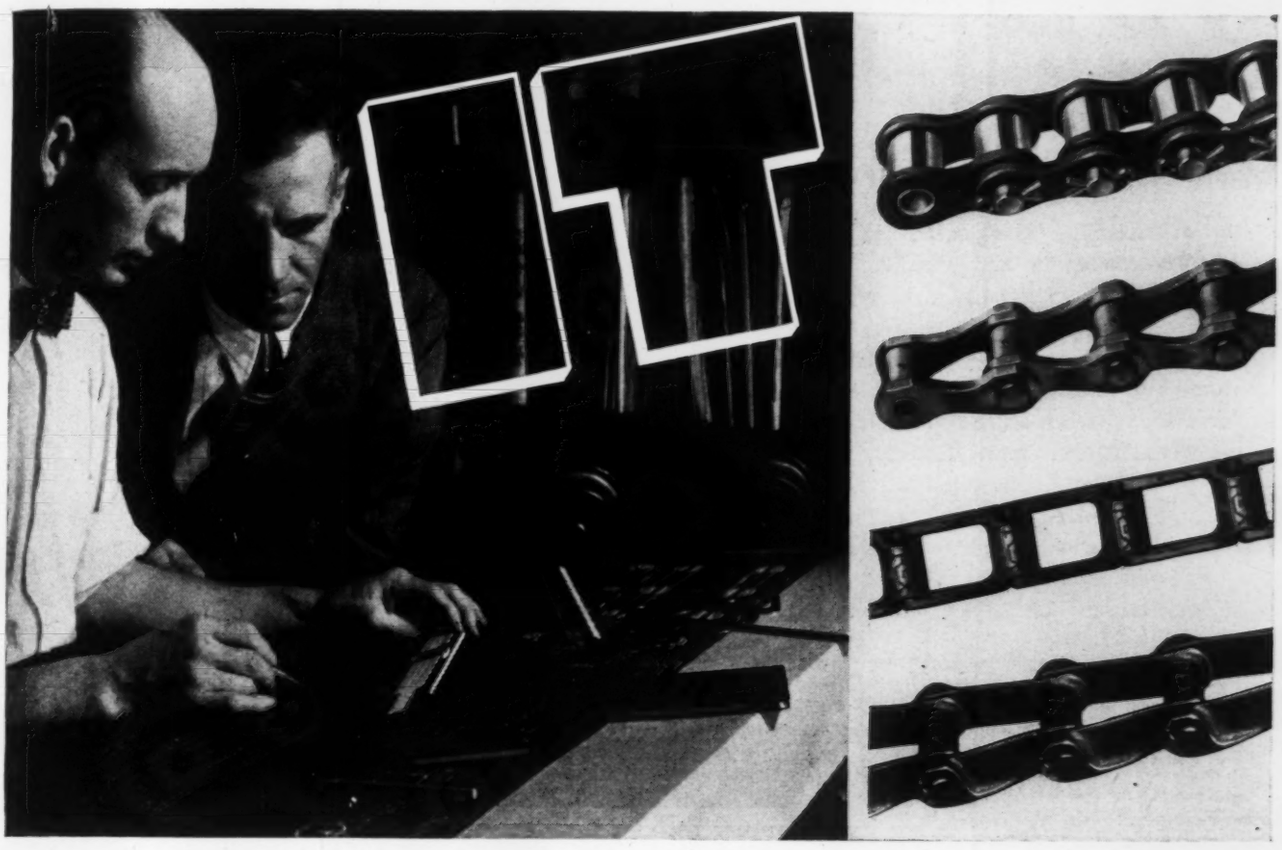

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Topics

MACHINES, along with sun spots, spiritual deterioration and President Roosevelt are popular scapegoats in the minds of many as the cause of world wide depressions and unemployment. We do not wish in these columns to attempt to analyze this problem, but we are confident that machines are not the blackguard. Using the words of Dr. James Thomas, from the magazine *Vital Speeches,* he remarks, "It is often stated that the machine puts people out of work, but between 1900 and 1930, the 30-year period of our most rapid technological development, we created 20,000,000 new jobs. The machine has been the most beneficial thing that has come to the working man on this planet, and the working man—who apparently is least informed about it—is the fellow who has reaped the greatest benefits from it. . . . The machine has democratized beautiful things and enabled masses to possess them for the first time in the history of the world."

♦ ♦ ♦

That applications of rubber and plastics are forging ahead rapidly is clearly evident from the attention now being devoted to these materials. Indicative of the trend, the American Society of Mechanical Engineers recently established a committee on rubber and plastics to deal with these growing industries and study mechanical applications of the materials. The committee will sponsor the presentation of papers at technical sessions of the regular quarterly meetings of the A.S.M.E. and a symposium on rubber is included in the program of the society meeting to be held October 5 to 7 at Providence, R. I.

♦ ♦ ♦

To prevent ice formation on airplane wings, a colloidal metal paint has been developed through which an electrical current may be passed. The method can be applied not only to the leading edges of the wings, but also to propellers, control members, radio antenna and other parts.

Another recent aeronautical revival is a two-propellered airplane, powered with a single motor. Now, however, the two propellers are both at the front of the machine, one just behind the other, and rotate in opposite directions. They are driven from separate drive shafts, one enclosed within the other. Chief advantage, says the War Department, is the elimination of engine torque without loss of propeller efficiency when operating at high speed.

♦ ♦ ♦

The efficacy of safety propaganda in the prevention of accidents is well illustrated in the steel industry, where the very nature of the work is of a more dangerous character than in most other industries. The 1937 frequency accident rate as disclosed by the National Safety Council, Inc., placed the steel industry 39 per cent below the all-industries average of 13.85 with a rate of 8.51. By the constant and diligent use of safety measures, accidents have been reduced 61 per cent since 1926. One cloud in the sky, so far as the steel industry is concerned, is the severity of accidents. Although it does not have many accidents, when one does occur it is apt to be maiming, placing the steel industry 31 per cent above the all-industries average for severity.

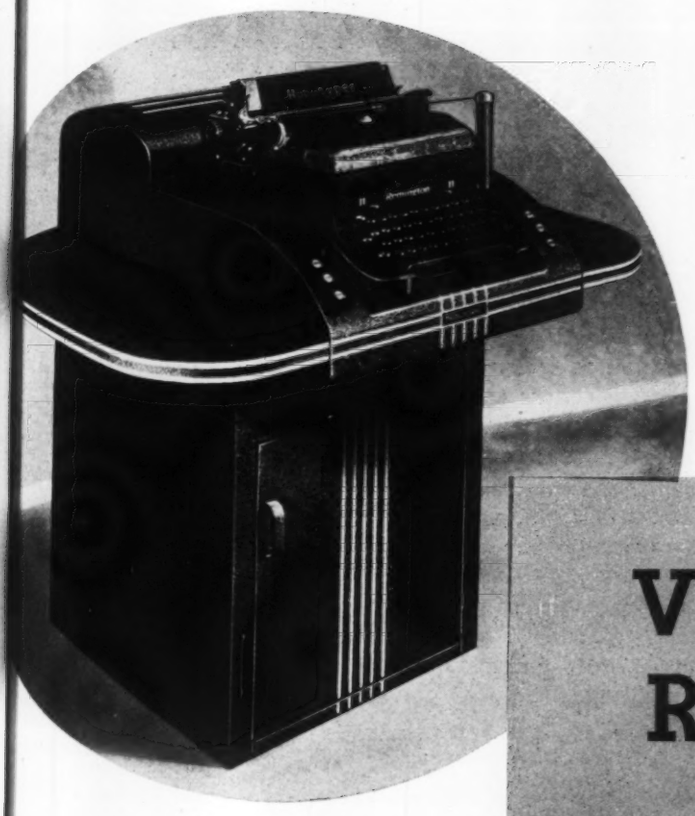
♦ ♦ ♦

Nothing is so insignificant or perfect that improvements cannot be made. Now we hear of a new method of riveting, used in Germany, which solves the problem of work in close quarters where it is hard to get at the shank of the rivet. A small explosive charge in the drilled-out end of the shank is exploded when an electrically heated dolly is held to the rivet head, the resulting expansion of the shank making a tight joint.

♦ ♦ ♦

MACHINE DESIGN has always pointed out how technical developments in one field help other industries or design progress in unrelated machines. A few weeks ago Western Union engineers demonstrated how 96 telegraphic messages can now be sent simultaneously in one direction over a single circuit by using different tone pitches to carry messages. The idea grew from experiments with the Hammond electric organ which utilizes different electrical frequencies to produce its musical tones. For purpose of the Western Union demonstration, a regular Hammond organ was used. A tone detective showed by means of lighted notes on a musical scale the frequencies of tones used to carry messages.

MACHINE DESIGN



Vacuum Operates Robot Typewriter

By George W. Carlson
Development Engineer
Automatic Business Machines Inc.

Fig. 1—Conventional typewriter rests snugly in Robotyper stand and all mechanism for driving machine is completely out of sight

INTO almost every field of productive endeavor the engineer and designer have sought to bring automatic devices to relieve or replace the human element or increase output. Ingenious mechanical movements and intricate electrical appliances are to be found wherever complex automatic operations are to be performed. The flexibility of electrical circuits and the fact that almost no motion is too complicated

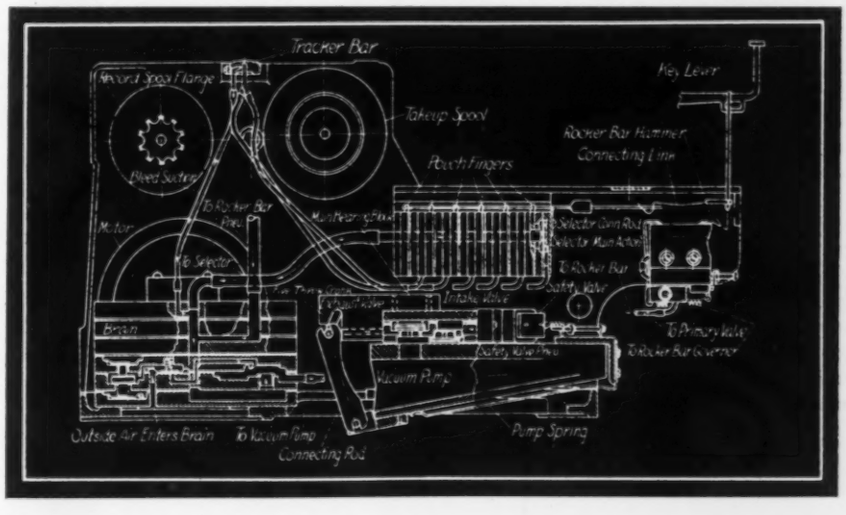


Fig. 2—Cross section of typewriter driving mechanism shows relation of parts, including the pump for producing a vacuum in the system

for properly arranged arms, cranks and levers have caused designers to overlook almost entirely one of the most primitive forces available to man—the force of vacuum. In fact, few designing engineers have full knowledge of what can be done with pneumatic-vacuum circuits, and to a much lesser extent is the average designer familiar with the elements of such circuits. The Robotyper, (*Fig.* 1) manufactured by Automatic Business Machines, Inc., presents an interesting example of the possibilities of vacuum or pneumatic principles to complex automatic operations. The Robotyper is a machine designed to produce individually typewritten letters with a speed and accuracy surpassing that of any typist.

Pneumatic actions have heretofore reached the highest phase of their development in the reproducing player pianos where all the variations of expression and tempo of the recording artist were attempted to be transferred to the perforated record roll and reproduced with an accurate measure of fidelity in the reproducing player piano. Reproducing typewriters have been marketed in which the player piano action, less the expression device, has been transferred to the office typewriter. At first glance, this appears to be a very feasible substitution but it is not so in fact. The typewriter leaves its reproduction in black and white on the printed page while the piano reproduction falls on the ear to be momentarily heard and then erased. Absolute accuracy is required with the typewriter while approximate accuracy satisfies even a discriminating listener. The typewriter keys must strike with uniform force to duplicate the work of the experienced typist whereas a wide variation in the force with which piano keys are hit is permissible. Each key in the typewriter must rise to strike the ribbon and then fall away before its successor may operate, whereas in the piano actions many keys may strike at once and be held for different lengths of time. These are just a few of the many differences, to say nothing of special functions such as line spacing, carriage return, paragraphing, etc., to be taken care of in the typewriter. Also, in developing the Robotyper, special consideration had to be given to compactness, as the space available for any piece of office equipment is limited. Material selection had to be made carefully to keep weight down, and parts specified that make little or no noise in operation.

The Robotyper uses any conventional typewriter. A perforated record roll similar to a piano roll moving across a perforated tracker bar causes the keys to be operated and the other functions of the typewriter to be performed. The roll and typewriter in position are shown in *Fig.* 3. A special feature of the pneumatic action is the fact that all of the character keys of the typewriter are actuated by the same pneumatic element, shown at the right of *Fig.*

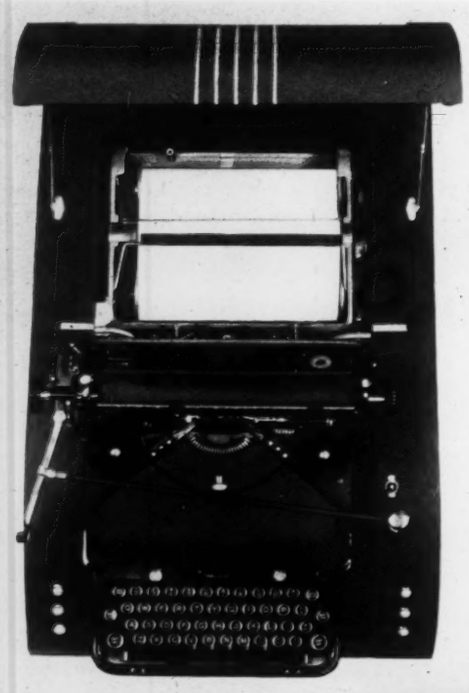


Fig. 3—Looking at machine from the top, one can see the position of the perforated record roll when the Robotyper hood is raised

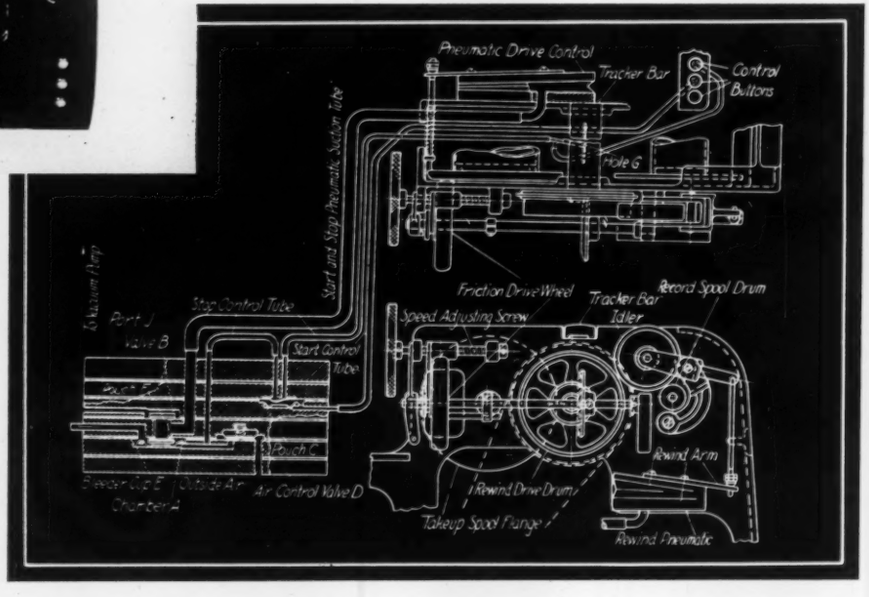


Fig. 4 — Diagrammatic view of mechanism for automatically starting and stopping machine is shown in blueprint. Brain for controlling air flow is seen in left corner, and winding and rewinding device in side view at right

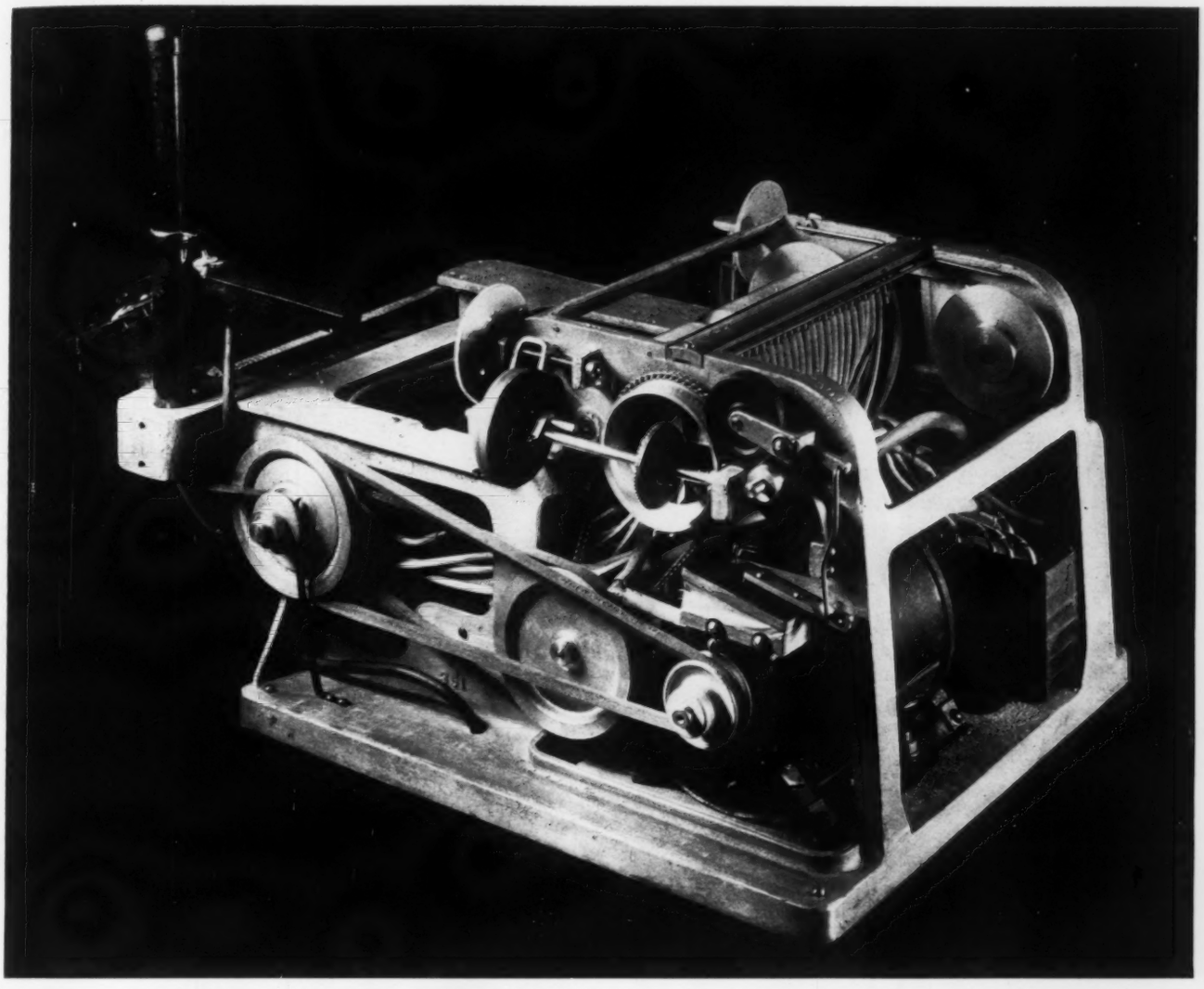


Fig. 5—One-piece aluminum frame gives lightness to the machine. V-belt drive from slow speed motor is quiet and affords further speed reduction. Belt sheaves and other small parts are aluminum

2. This element, known as the rocker bar, moves up and down by air impulses admitted through the record and tracker bar. Before each down stroke of the rocker bar, a selector pulls a hook attached to one of the typewriter character keys into the path of travel of the rocker bar, so that, as the rocker bar moves down, it pulls down the selected character key. Each key is therefore moved with the same speed and force.

It is interesting in passing to note that the rocker bar is capable of two thousand complete strokes a minute, whereas the best that could be expected from electric solenoid operations would be 800 similar strokes, and this only with excessive heating. No typewriter has been developed capable of being operated this fast; 175 key strokes per minute is close to the practical maximum, and reference to the high speed is made only to show the possibilities of pneumatic devices of this character. Also, it may be mentioned that it is a very silent action as compared with either mechanical systems using cams, levers or solenoids having heavy iron cores.

The typewriting record consists of a roll of specially prepared paper, wound on a cardboard core and perforated like a player-piano roll. The perforations are made in the record by a simple device, operated much like a typewriter and illustrated in *Fig.* 6.

The selector, which picks out the key to be operated, finds no counterpart in player piano or other pneumatic circuits. It employs differential diaphrams, the larger of which respond to air coming through the tracker bar opening to make the selection, and the smaller one being biased by vacuum to return the parts to normal position after each selection—there, of course, being one set of these differential diaphragms, or pouches as they are called in the pneumatic field, for each character key. The selector has no valves whatever. The selector and rocker bar unit can be placed under a standard typewriter, and being only about three inches high little space is required.

Complete and adequate sealing of the pneumatic system was one of the first design considerations in a machine of this type. Any leakage would seriously

hinder its operation and be a constant source of trouble. Few better materials could be found than wood for building vacuum pump, control box and other parts of the machine in which a vacuum was to be created. Wood not only can be easily sealed with glue or shellac but it is light and economical. The control box shown at the left of *Fig.* 2 is made of six wooden layers glued together. Air passages, valves and vents are easily machined in the wood and the entire unit serves its purpose admirably.

To give a continuous and nonpulsating vacuum five separate bellows-type pumps make up the pumping unit. They are driven by a single five-throw crank, which receives its power through a V-belt from a 1/12-horsepower motor running at 1140 RPM. Each pump has a flat spring, easily seen in *Fig.* 2, which keeps the movable section of the bellows tight against the connecting-rod journals, thus preventing lost motion and reducing wear and noise. Specially treated leather is used for the action diaphragms and after several years of operation this leather has been found to be in good condition although creased at every movement of the bellows.

Framework of the machine is aluminum. Here

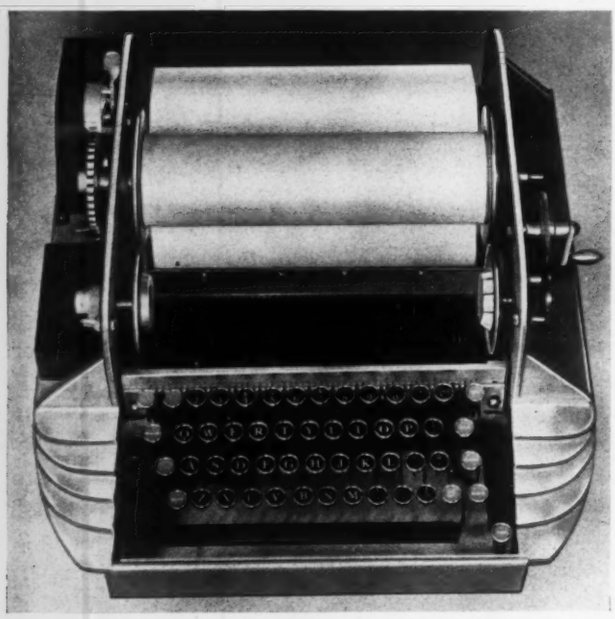


Fig. 6—Device, similar to typewriter, is used for making perforations in record roll. Power for turning roll is supplied from the Robotyper

again selection has been made to obtain light weight. Pulleys, roll spools and other small parts are also made of aluminum for weight reduction. These parts are easily seen in *Fig.* 5. The conventional type of graphite impregnated bronze bearings is used throughout the machine to avoid the necessity for frequent lubrication.

The sole use of electricity in the Robotyper is to drive the small motor. Main vacuum pump and roll spools are driven directly by the motor; all other operations of the machine are pneumatically driven or controlled. As can be seen in *Fig.* 5 a chain is used to transmit power from belt pulley to the rewind drive drum. Through a pair of bevel gears, drive is transmitted to a shaft having a hard rubber caster which presses on roll spool flange and turns it through friction contact giving a smooth and silent drive. Wheel can easily be moved by adjustment to give any speed desired to spool. To rewind the roll, vacuum is automatically applied to the rewind pneumatic which moves idler rubber wheel caster in contact with the rewind drive drum and the rewind spindle; simultaneously the other friction wheel is moved away from the roll spool flange.

Start and stop mechanism of the machine is automatic and illustrates the ingenious method of controlling the typewriter. To clarify the operation we will follow through the pneumatic system and see just how the start and stop mechanism works. Vacuum produced in the main pumping unit is piped directly to the "brain" of the machine. When in use chamber *A, Fig.* 4, is continuously under vacuum and thus holds valve *B* on its upper seat, establishing a vacuum in the start and stop bellows. The bellows are connected to the friction driving wheel by a rod and, while collapsed, hold the friction wheel against the takeup spool flange.

Revolution of the takeup spool draws the perforated roll across the top of the tracker bar and whenever a perforation passes over hole *G, Fig.* 4, in the tracker bar, outside air is admitted to the under side of pouch *F,* closing valve *B* against its lower seat. This allows outside air to enter through port *J* and the start and stop bellows are opened by a spring shown in the drawing. The friction wheel is thereby forced away from the takeup spool flange and the machine stopped.

The machine may also be stopped manually by pressing the stop button on the control board, thereby admitting air into the same line as that leading from hole *G* in the tracker bar.

When hole *G* is uncovered, the machine is started by pressing the start button on the control board. This admits outside air to the under side of pouch *C* which closes the passage. The air now bleeds from the under side of pouch *F,* valve *A* closes upon its upper seat and suction causes the start and stop system to collapse, drawing the friction wheel against flange *E,* and the Robotyper is again in operation.

All functions of the machine are co-related through the control box or "brain" which in turn receives its impulses either from the record or manual control buttons. For example, when the record is rewinding, the keys must not operate so the brain renders the key action inoperative on the rewind.

The machine demonstrates to the engineer the flexibility of pneumatic vacuum systems for the high speed automatic performance of complex operations, and it is believed that similar principles can be effectively utilized in various fields.

Scanning THE FIELD FOR Ideas

STEAM enters a turbine at a temperature hot enough to set fire to a piece of wood, then .03 of a second later leaves it at a temperature too cool for a comfortable bath. It enters at pressure as high as 1200 pounds per square inch and leaves at vacuum as low as one-thirtieth of an atmosphere. Peripheral speed of recent large turbine rotors is approximately 820-miles per hour—80-miles per hour faster than the speed of sound. These are some of the interesting facts pointed out by W. E. Blowney of the turbine engineering department of the General Electric Co., in his paper at the recent Wid-West Power conference.

In 1903, the largest turbine generator in service was a 5000-kilowatt machine installed at Chicago. It was ten times larger than any previous unit. Today the largest machine in service, also at Chicago, is 42 times the size of that 1903 "colossal," Mr. Blowney declared.

Initial steam temperature in turbines having reached the 950-degree Fahrenheit range, further progress to still higher temperatures is limited until "low creep" materials become available. The subject of "creep," which is the permanent deformation of metals under stress while hot, is now the subject of intensive investigation.

"Writhing Rotor" Is Die Cast

THE rotor of the new Granco high-pressure, positive-displacement pump shown in the upper section of *Fig.* 1, marks an interesting departure in pump design. This unique creation by the engineers of the Granberg Equipment Co. operates like a universal joint "writhing" between two shafts (driver and driven) set at an angle of 30-degrees between axes and is composed of three sturdy zinc alloy die castings assembled into a spherical unit. These three castings appear in the lower section of the illustration. As the driver shaft makes one revolution, four wedge-shaped chambers of the rotor are opened and closed in succession, thereby sucking in and squeezing out charges of the fluid being pumped.

Of special interest is the fact that these ingenious rotor parts could not be made by any method other than die casting without prohibitive machining on nearly every surface. As it is, no machining whatsoever is required on this "heart of the unit", for the fits are exact and surfaces are satin-smooth "as cast". Furthermore, all holes and keyways are cored to size.

Designed principally for high-pressure oil delivery, this unique pump is also finding wide application for other liquids such as butane and chemical fluids. It is self-lubricating, rugged, compact, and quiet. It requires no adjustments between its single moving part and the housing; carries no valves, gears, plungers, springs, or rings; holds a minimum of liquid at any instant; and blows itself dry in a single revolution.

Lighting the Path for Shavers

AS HAS been true for some time in the case of advanced types of vacuum cleaners, electric lighting of the path of operation has now been made possible in connection with the leading makes of electric

Fig. 1—Heart of this positive displacement pump is a "universal joint impeller" assembled from die castings

razors. The manner in which this is accomplished is revealed by *Fig.* 2, below.

While this Shaverlite is called an attachment, it does to all intents and purposes become a part of the

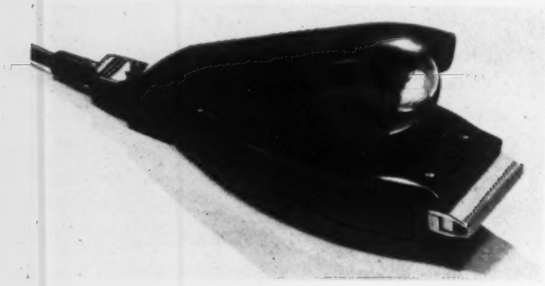


Fig. 2—Plugged in between shaver and cord, this attachment illuminates the path of action

dry shaver assembly when plugged in between the body of the shaver and its electric cord. The device is molded in such a manner that it holds itself snugly against the body of the instrument.

Illumination is furnished by a standard type of 110-volt, 6-watt General Electric Mazda bulb.

Pneumatic Device Times Welds

AUTOMATIC control of current in resistance welding is of great importance not only in speeding up the work but also in improving the quality of welds. With this in mind, engineers of the Thomson-Gibb Electric Welding Co. have devoted much attention to the development of various kinds of precision timing equipment, including the pneumatic timer shown by the section drawing, *Fig.* 3.

In the diagram, *A* and *C* are diaphragms forming upper and lower air chambers. Air forced into the lower chamber through release valve *B* returns to the upper chamber through needle valve *D*. Transfer time can be regulated very accurately and the motion

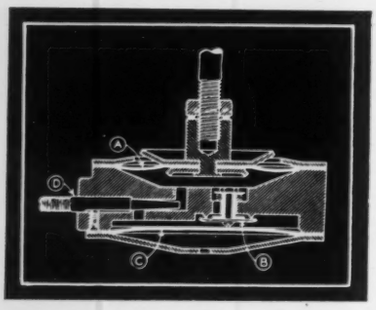


Fig. 3 — Diagram showing cross section of pneumatic timer designed for use with resistance welders

of the rod at the top is used to control the welding periods.

This unit can be set up in a simple circuit to operate a magnetic contactor at the end of the predetermined welding period or it can be arranged with a series of relays to provide pressure build-up, welding time, delay or weld-setting time and off time—in continuous sequence.

This is a generally satisfactory type of timer for spot and projection welding of ferrous metals, or for work where extremely short cycle timing of relatively heavy loads is not required.

Earth Movers Demand Big Tires

PNEUMATIC tires constantly are being applied successfully to new and sometimes extraordinary uses, as has been pointed out on more than one occasion in this department. We are now able to point out still another such development, which is exemplified by the huge tire which appears in *Fig.* 4, below.

At the moment this is reputed to be the largest heavy duty truck tire ever made. It is what is known as size 24.00-32, weighs 1200 pounds, and is one of

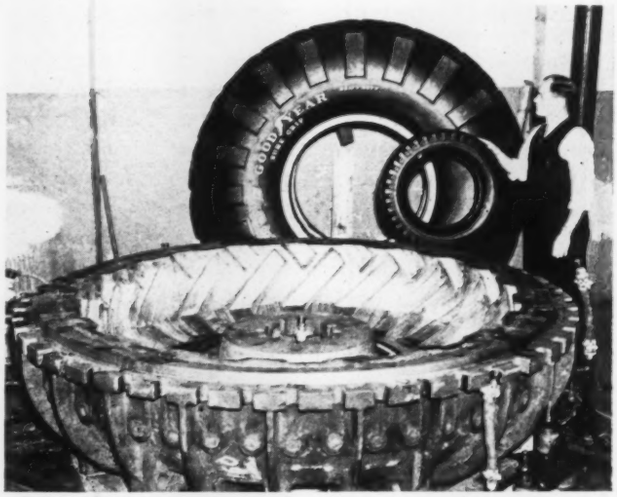


Fig. 4—Reputed to be the largest heavy duty truck tire ever built, this one is for earth moving vehicles

a series built by the Goodyear Tire & Rubber Co. for a manufacturer of large earth-moving vehicles. This 30-ply tire when inflated to 75 pounds per inch has load-carrying capacity of 25,000 pounds.

The tire has an outside diameter of 82 inches, which —as is obvious from the illustration—is about a foot more than the height of an average man. Its cross section measures 25 inches and its rim diameter is 32 inches. The big tire fits a rim 17-inches wide, the flange of which is 3½-inches high. Incidentally, the protection flap alone weighs 17 pounds. Note the comparison with a standard 6.00-16 automobile tire of similar design.

In the foreground of the illustration is the special mold which had to be designed and built for the vulcanizing of these huge tires. This mold weighs 13½ tons. Another mold weighing 10,500 pounds had to be designed and built to handle the tube.

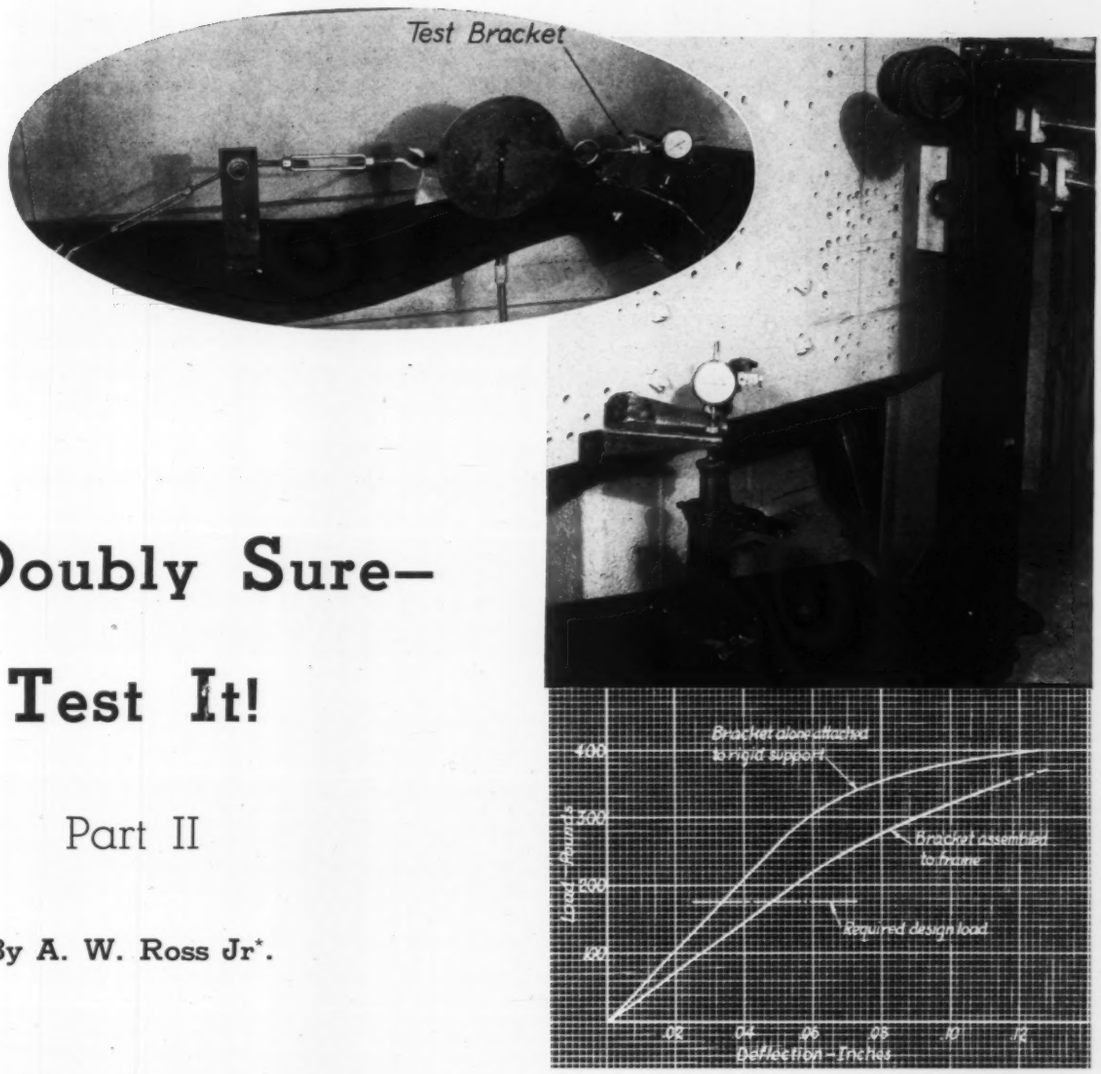


Fig. 1—Bracket to be tested is loaded by turnbuckle and spring scale as shown at upper left. To determine if deflection is in bracket or supporting structure, test depicted above is conducted. Chart shows deflection under the two conditions

Be Doubly Sure—Test It!

Part II

By A. W. Ross Jr*.

WHERE do test problems originate? When do they originate? What is to be accomplished by testing?

The source of test problems may be with the designer, checker, analyst, engineer, production department, service department or the executive with final responsibility for the quality or cost of a design. Test problems may originate with the first lines on the drawing board or after the product has undergone lengthy critical service.

A part is laid out in the drafting room. The designer is doubtful as to the necessary gage of material, the location of ribs or the most preferable of several possible forms. A test suggests itself as a means of obtaining the answer. . . . Details of parts are submitted to an analyst for check. His calculations and experience dictate the regular sections but certain of the details are so irregular or complex as to be beyond strength prediction by available theory. Testing is available for expanding his knowledge of the behavior of such details. As an example:

A bracket is designed on the board and submitted to the stress analyst for check. Irregular form and method of attachment make precise calculations of strength and deflection impractical. The bracket is submitted for test. It is bolted in place on the actual frame (duplicating the proposed assembly) and loaded by means of a spring scale and turnbuckle (*Fig.* 1 upper left view). Deflections are measured by an indicator. The test load is carried to twice that which the part will be called upon to resist, showing strength to be adequate. But a decision must be made as to whether the deflection (which is measured by test) is to be tolerated.

In order to differentiate between deflection of bracket and of supporting frame, a second test (*Fig.* 1, above) is run with the bracket alone mounted on a rigid plate. The bracket is shown to account for about two-thirds of the total deflection.

Where a part fails in service it is important that the engineer know the nature of the loads that caused

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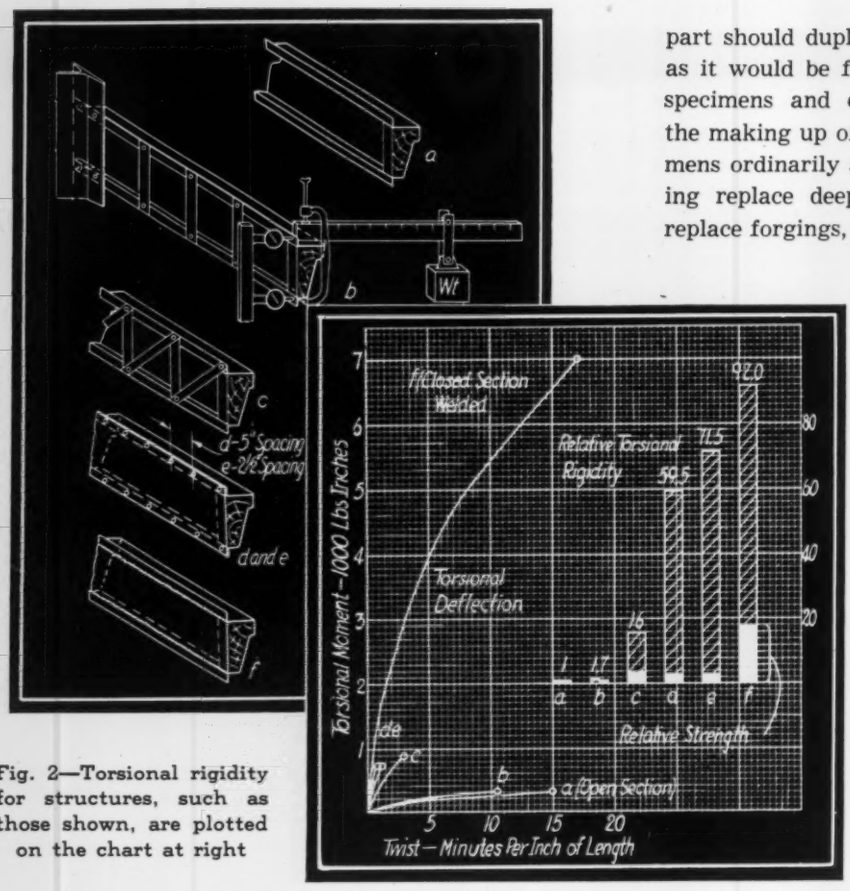


Fig. 2—Torsional rigidity for structures, such as those shown, are plotted on the chart at right

failure. The part therefore is tested to destruction to duplicate the failure and to obtain this information . . . . If a frame or housing is found to be too flexible to perform its function properly, deflection measurements of the loaded structure allocate the deflection to the critical details and permit an intelligent revision . . . . When the production department or a vendor submits an alternate design that shows a cost advantage, but leaves the strength questionable, the engineer responsible for the design avails himself of tests to verify his judgment.

The answer to questions concerned with the structural integrity of a part or assembly (which functions to resist loads) is given by tests. And the answer is accurate, and easily and quickly obtained.

TEST SPECIMENS—The specimen to be tested may be obtained from any of a number of sources depending upon the stage of the development of the design, its size or its cost.

A production part always is best, since it is the properties of the average piece that are wanted, and production parts are the cheapest of specimens. Tests of production parts provide data for changes to increase strength or decrease cost or furnish valuable information applicable to similar future designs.

The earlier in the development of a part that test data is available, the more valuable it will be. Data is most urgently needed while a design is still on the drafting board. This requires that an experimental part be built up from the preliminary design. The part should duplicate, as nearly as possible, the part as it would be fabricated for production. Since test specimens and experimental parts do not warrant the making up of expensive dies or molds, such specimens ordinarily are handmade, and cutting and welding replace deep draw operations; machined parts replace forgings, etc. The differences should be recognized and given consideration in the interpretation of test results. There is a decided tendency in fabricating experimental parts to over-weld and in other ways make the handmade parts unnecessarily strong; whereas, because of cost considerations, production parts are skimped to the lower limits of specified requirements. When a part is being made up for test purposes the amount of welding should be carefully controlled and the specimen closely followed to insure similarity to contemplated production.

Where the design unit would be too large for convenient or economical handling or too expensive to build up experimentally, models may be used for test. Even greater care is required in making models to give dependable results significant of the actual part.

Arbitrary test specimens may serve a useful purpose. They may be designed to establish general analysis data or to provide a demonstration of a principle that the designer can apply to advantage. The author has in mind specimens built up to determine the effect of lightening holes through a range of sizes and the effect of flanging such holes; specimens designed for the determination of the structural characteristics of typical details; the strength of production welds; or the deflection properties of irregular thin-walled sections.

Information is required on the torsional rigidity of a construction approximated by the section shown as *Fig. 2a*. The test specimen is easily fabricated in the shop. For test it is attached to a supporting structure and, at the free end, a bar is clamped as shown in the illustration. Indicators are mounted and a weight is provided which, when moved along the bar, varies the applied couple within the range necessary for the test. Additional specimens (*b* to *f* inclusive) are tested. Torsional deflection is plotted against applied moment. The specimen boxed and welded, *f*, is shown to be 92 times as rigid and 18 times as strong as the original open section *a*. And it is shown that the specimens with the plate bolted in place, *d* and *e*, do not develop the full properties of a closed section as represented by the welded specimen.

The specimens and test, of the example given, not only provide the necessary data concerning the specific section in question but furnish a conclusive demon-

stration of the principle that closed sections are many times more rigid torsionally than are open ones.

LOADS TO BE APPLIED TO THE SPECIMEN—The applied loads form the basic assumption and influence materially the accuracy of results of tests. (This holds equally true for analysis).

Loads which a structure must be designed to support or withstand may be:

(1) Static weight of the structure itself.
(2) Static weights of all superimposed units and assemblies, passengers, cargo, etc.
(3) Forces applied by mechanical or manual power.
(4) Mechanical forces rapidly repeated.
(5) Multiples of the loads of (1) and (2) due to accelerations of the masses.

Points of application of the weights and forces are established from the specimen itself and a knowledge of the application in service. Direction of forces is similarly established and the direction of the force of gravity gives the line of action of the specimen and pay load weights. The magnitude of the forces is the most important consideration and must be established from service, experience and designers' judgment. These are the forces that the structure must demonstrate that it can withstand to provide adequate safety and perform its function properly.

Static Forces Easy to Test

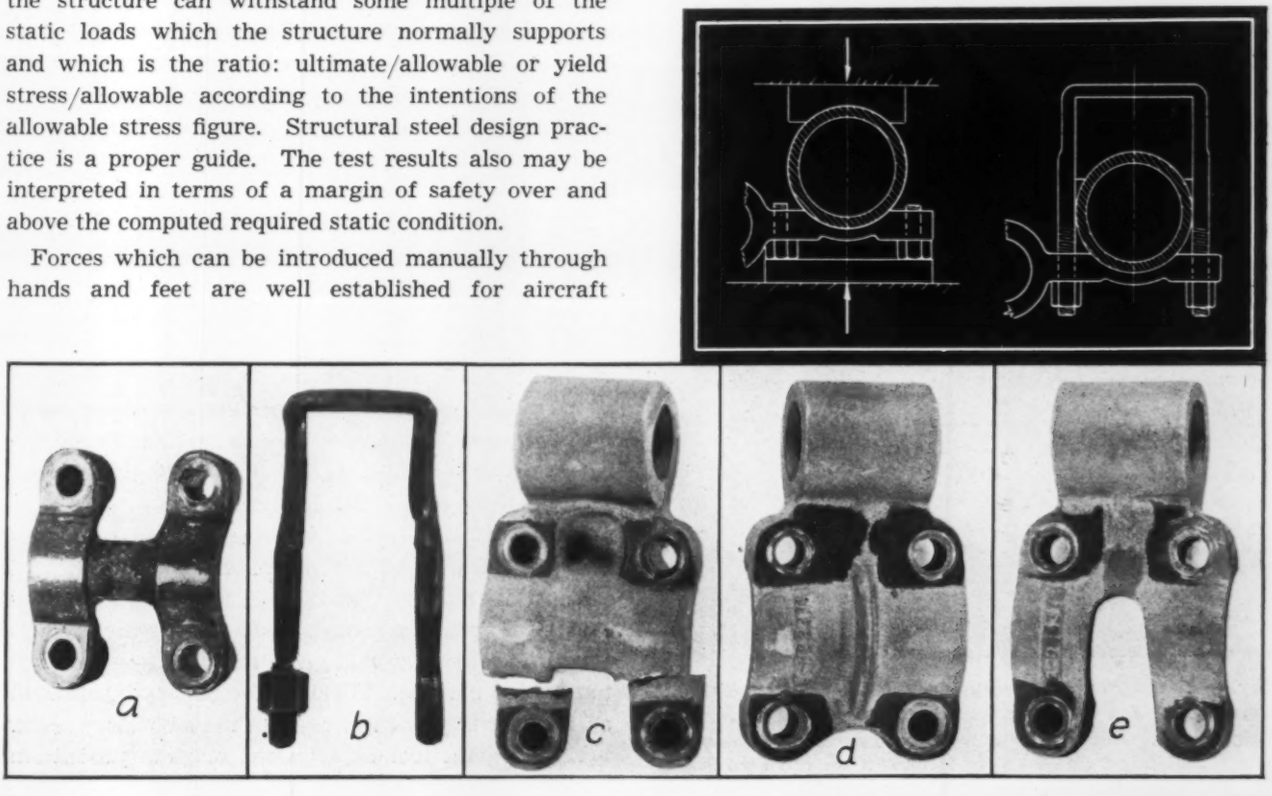
For static structures, structures that are called upon to support only static loads and their own weight, an allowable stress is established and designed to. For test purposes then, it is proposed to demonstrate that the structure can withstand some multiple of the static loads which the structure normally supports and which is the ratio: ultimate/allowable or yield stress/allowable according to the intentions of the allowable stress figure. Structural steel design practice is a proper guide. The test results also may be interpreted in terms of a margin of safety over and above the computed required static condition.

Forces which can be introduced manually through hands and feet are well established for aircraft purposes and are equally applicable in other cases where such loads exist. Mechanical forces from power units are computable by the common methods of mechanical engineering.

Repeated loads are handled satisfactorily if the ratio of fatigue limit to yield or ultimate stress is known with reasonable accuracy. If the importance of the project warrants, repeated load tests can be conducted.

Increased loads due to accelerations are characteristic of such "machines" as airplanes and automobiles and influence the design of their structural parts. Accelerations are taken care of, in the case of airplane design, by the use of load factors, one load factor representing the static load condition. Thus, for certain types and weights of airplanes, for normal landing conditions, a load factor of 5.0 applies. When possible, service conditions should be evaluated by accelerometers or other instruments. Every effort should be made to establish reasonable values so the ultimate in economy can be realized. We are reluctant to discuss this subject of loads due to accelerations in great detail for fear of giving the impression of complexity to testing, whereas it has been the aim to present testing as a simple expedient tool. In fact, this type of loading has little application to stationary machines and the average test problem will not be complicated here by any detailed con-

Fig. 3—Design revision dictates substitution of casting for forging to provide bearing retainer. At "a" is forged part and "c", "d" and "e" illustrate the steps in the development of a suitable casting. Method of testing is shown in the drawings

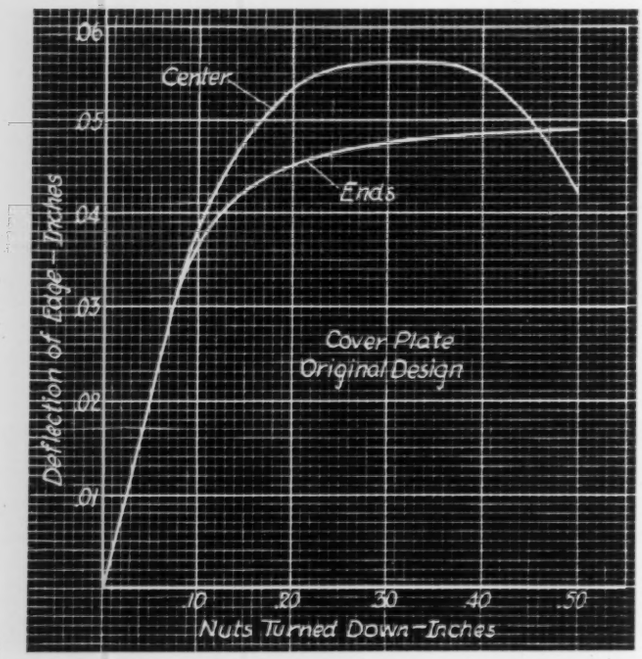


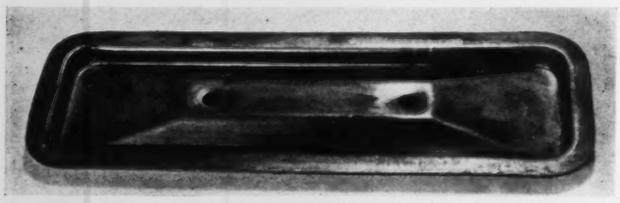
sideration of it in the present article.

REQUIRED STRENGTH BY COMPARISON—There remains a method of establishing necessary strength that has a wide application in most test work. A new design is projected. There is available, from previous models of the product, similar parts that have a satisfactory service record and the same function as the proposed design. By conducting parallel tests of the old and new parts, direct comparison is possible and the new part verified for adequate strength. If by any chance there exists a service record of an unsatisfactory part, this will provide a means of confining the required strength within close limits.

A revision in design to provide a bearing retainer dictates that the production forging (*Fig.* 3*a*) be replaced by a malleable casting. The design *c* is proposed and submitted for test. As a first test, the part submitted is assembled with U-bolts, *b*, a block and section of tubing as shown, duplicating actual assembly. Nuts on the U-bolts are turned down with equal and known torques (measured by using a spring balance at the end of a wrench handle) until the experimental part ruptures. The bolt has elongated appreciably (as *Fig.* 3*c* on the right-hand side). But similarly tested, the production forging does not fail, the bolts being the critical part. In consideration of service requirements, an increased section is recommended. The design division goes "whole-hog" and submits a part of increased thickness (from ¼ to ⅜ inches) and with a rib added for good measure. The bolts are now critical but the part is considered excessively heavy. It is cut down, *e*, and the test demonstrates that the part still is superior to the bolt, hence of adequate strength.

As a further check, a second test is made and the ultimate strengths of the parts determined in a testing machine. These strengths are reported in Table I. U-bolts at the upper limit of specified hardness are selected from stock and the strength of the two bolts is reported. The margin of overstrength of the proposed part is accepted as being proof of the adequacy of the design. Note (in Table I) that the weight of the recommended part is identical with that of the unsatisfactory original design. Rigidity of the part is considered to be of importance because of the possibility of the bolts loosening if excessive deflection occurs. The proposed design is found to be superior to the forging which it replaces.





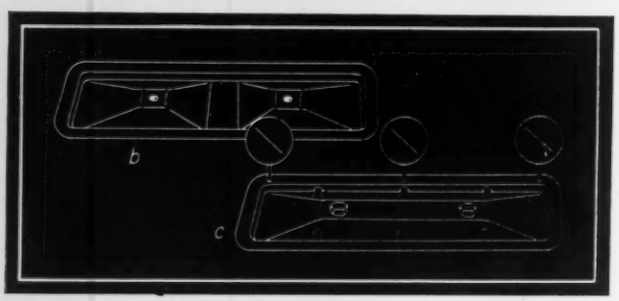


Fig. 4—Steps in the development of a satisfactory valve cover plate are shown above. The photograph is the original part and the drawings indicate different designs. Deflection of the cover is shown on the chart

TABLE I

Part	Fig. 3	Load at Rupture (lbs. per sq. in.)	Margin* of Safety	Defl.†	Perm.† Set	Weight of Part
Production Part..	*a*	140,000	0.43	0.021	0.012	2.19
Forging Production ..... U-Bolts (Two)	*b*	98,000				
Original Proposal	*c*	80,000	—0.11	0.023	0.013	2.66
Second Proposal..	*d*	135,000	0.38	0.005	0.002	3.03
Final Design.....	*e*	120,000	0.22	0.011	0.005	2.66

Note: (*a*) Satisfactory service record. (*b*) Satisfactory service record. (*c*) Not satisfactory. (*d*) Excessive weight. (*e*) Recommended.
*Based on strength of U-bolts.
†Deflections and permanent sets at average torques on U-bolt nuts.

Required strengths of the test described were established from the parts with a satisfactory service record.

A RULE FOR TESTING—The loads which are applied to a specimen are established to correspond, as nearly as possible, to the actual loads which the part will encounter in service. In fact, the whole technique of successful structural testing of a minor part or a major assembly is founded on a single rule: *Duplicate, as nearly as possible, the actual conditions to which the unit will be subjected in service.*

TESTING TO INFLUENCE DESIGN—Consider a test program intended to perfect a design. For purposes of illustration, assume that there is available a production part that has given satisfactory service but is heavy, with corresponding high cost. It is proposed to redesign the unit. This new design may be initiated on the drawing board or right in the laboratory itself.

First, obtain test data on the original production

part. Determine its strength, critical section and deflection characteristics. If the required strength is known, a margin of overstrength can be determined and this margin can be utilized in effecting an economy. Without a knowledge of this margin it might be necessary to require the new part to be as strong and rigid as the old.

Cost may be reduced by:

(1) Reducing the amount of material (with corresponding advantages in reduced weight)
(2) Reducing quality of material
(3) Reducing fabrication costs (simplicity of design).

As regards quality, it should be kept in mind that the modulus of elasticity remains very nearly constant for all steels regardless of quality, hardness or heat treatment. Therefore, deflections are in no way influenced by a change in quality or hardness; moreover, the strengths of long columns and the critical strengths where thin sheets account for local failure likewise are not affected by quality.

Lightening Holes for Weight Reduction

METHOD OF REDESIGN BY LABORATORY TEST—Assuming that the part is a casting or forging, or made up of relatively heavy plates, cut down (by machining or other method) certain of the flange widths, web thicknesses, ribs, etc., *that showed no failure in the original test.* Carefully avoid changing the critical section or parts which support it. Progressive tests will determine whether the changes have reduced the strength below requirements.

The use of lightening holes is a method of weight reduction that may affect strength and rigidity little if at all. These can be introduced and increased in size until the critical size is reached. Lightening holes have a definite application in webs whose thickness is established by fabrication limitations rather than strength, or where channels are formed of flat stock and webs are of a thickness equal to that of the flanges, which ordinarily is an uneconomical proportion.

When the part being considered is built up of members of flat stock, progressive testing may be accomplished by rebuilding specimens using lighter gages in non-critical parts. Trimming of edges, notching between rivets and notching gussets as well as adding lightening holes can be tried.

Flanging lightening holes may add sufficient stiffness to permit larger holes than allowable of the unflanged variety. In some cases, webs with flanged holes increase strength by giving better support to adjacent parts than does the unlightened web. Turning of a flange may provide the necessary strength that a reduction in gage has cut below the requirements.

Where a part has shown a lack of strength in service, minor modifications in the form may be incorporated to improve the performance.

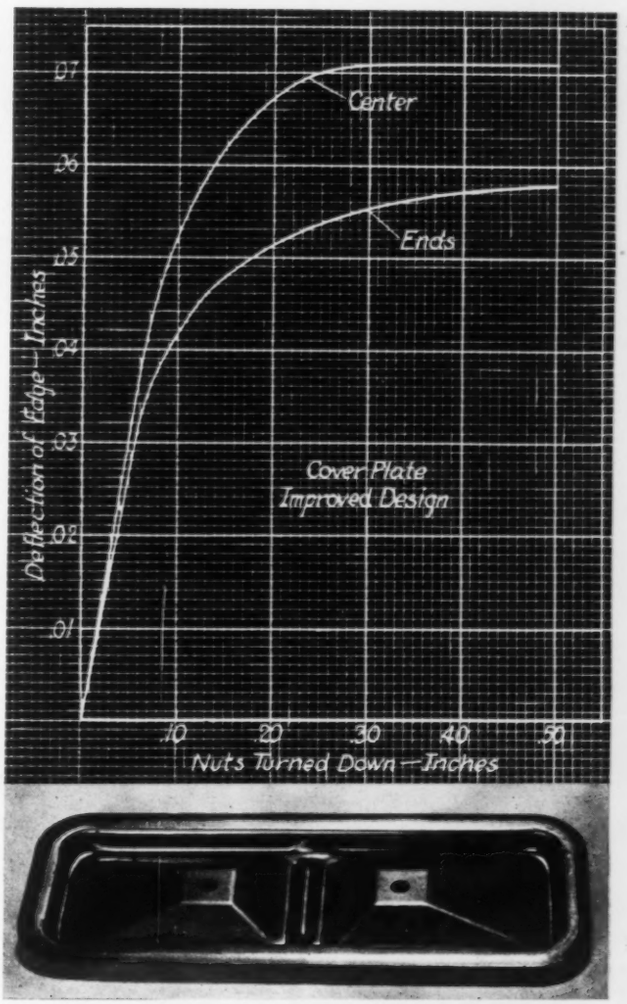


Fig. 5—Introduction of a bead between plate pyramids gives adequate strength to cover plate as chart shows

A cover plate is required to be oiltight. Service reports that oil leakages occur. This is traced to the fact that mechanics when replacing this plate tend to overtighten the bolts, with accompanying buckling of the plate and distortion of the edges which normally provide the seal by bearing against the gasket. Can minor modifications perfect the design without resorting to the more obvious method of increasing the gage?

A production plate is assembled to the actual housing and in the normal manner. Indicators are mounted along the edge; the bolts are tightened in increments of .05 inches; the test results are plotted as curves. (*Fig.* 4). The rising curves indicate increasing compression of the bearing edge on the gasket. But as the bolts are tightened beyond .30 inches, the curve for the center of the plate falls away, indicating reduced compression or roll which was originally noted as accounting for leakage. The problem becomes one of developing a plate that (within reasonable limits of bolt tightening) gives curves that do not have this characteristic of falling away.

Proposed cover plate forms are made up by heating and reforming the production parts. The "double pyramids" of *Fig.* 4*b*, upper view of sketch, fail to improve the condition. Shallow darts, *Fig.* 4*c*, also

are not effective. But the introduction of a bead between the pyramids *Fig.* 5 gives the desired form of curve. This proposed form is adopted for production. The chart, *Fig.* 5, shows the increased strength.

MINOR CHANGES MAINTAINING THE BASIC DESIGN—Rivet or weld spacing can be increased and the decrease in strength verified by test. Such changes maintain the basic design and the saving is a direct one.

Still maintaining the basic design, there are minor design revisions that have useful application. These may take the form of stiffeners added to webs of drastically reduced gage or other local reinforcements to make up for reductions in material thickness. It is necessary to balance the weight of reinforcements and increased fabricating cost against the primary weight saving.

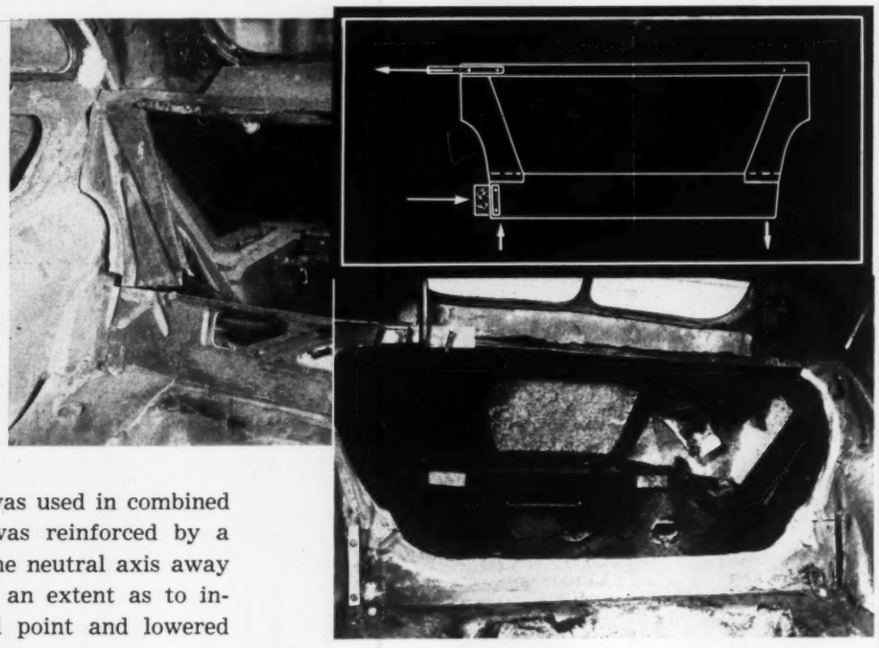


Fig. 6—To test panel that has been reduced in section to give better access to baggage compartment back of auto rear seat, it is sheared (left-hand view) and a force applied. By reducing widths of parts that buckled strength is increased. Drawing shows loss in rigidity is negligible

A member of irregular form was used in combined compression and bending. It was reinforced by a cover plate. The plate shifted the neutral axis away from the critical flange to such an extent as to increase the stress at the critical point and lowered rather than increased the strength.

There often are cases in practical structures where active structures parallel each other. Such cases exist where thin gage metal shells supplement primary structures of heavy but shallow members. The thin deep sections have a rigidity out of all proportion to their strength. As a consequence they carry a great part of the load and fail by buckling before the primary structure actually becomes active. By decreasing the rigidity of the secondary sheet metal, reducing its depth or changing its form, buckling is retarded and the useable strength increased.

Automobile body construction provides us with an example, but the general principle has universal application.

A reduction in the widths of the parts that form the bulkhead back of the car rear seat is proposed to provide better access to the baggage space (the example is one taken from a model, now obsolete, where luggage was loaded from the inside by lifting the seat back cushion). Will the reduction in section be consistent with structural requirements?

The satisfactory production assembly is tested by shearing the panel. Ultimate failure results when the wide but thin parts buckle and the welds tear (*Fig.* 6, left). Widths of parts are reduced to required dimensions by cutting away the excess material and approximating the proposed sections (*Fig.* 6, lower right). The test is repeated and *demonstrates that the strength has been materially increased.* The loss in rigidity is shown to be negligible by the chart accompanying the illustrations.

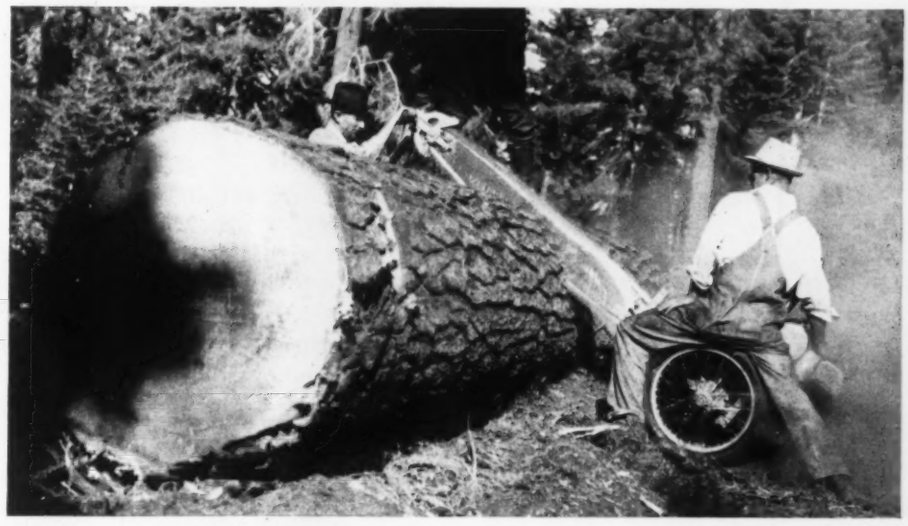
The increase in strength of the example was easily explained. The wide parts were rigid and carried almost the total shear load but they lacked lateral support and local strength. With narrower sections, the particular frame was less rigid and the back panel of the car was permitted to carry its share of the load. The bulkhead was called upon to carry less load and, because of the more favorable proportions of its parts, was better able to resist such loads as it did carry.

METHOD OF PROGRESSIVE REINFORCEMENT—Complete new designs originate on the drafting board but can be checked against the original design by test. Where such designs prove of insufficient strength, the method of progressive reinforcement may be used; increasing gages, widths, rivets, etc., until adequate strength is reached. Here, the procedure consists of reinforcing at the critical section, forcing the failure to a new location and, in turn, reinforcing at this new point.

The various procedures which have been outlined can be summarized under the general term "Cut and Try". But "cut and try" as a testing procedure has been proved to be a simple, efficient, expedient and entirely practical method of improving a product.

Part III of this series, to appear in the September issue of MACHINE DESIGN, will deal with the different methods of conducting the simple structural test.

Fig. 1—Having accomplished the "falling" of this big tree, the portable power saw is now rapidly "bucking" the trunk into logs of suitable length



Portable Power Saws Must Be Designed to "Take It"!

By Paul Christiansen

Chief Engineer

Dow Pump and Diesel Engine Co.

ALTHOUGH practically every other phase of the lumber industry has long since been converted to high efficiency methods, including power-driven machinery, sawing in the woods still is to a large extent done slowly, strenuously and expensively —by hand. However, transition from the axe and the cross-cut saw to power saws definitely is on its way.

Therefore, the portable power saw is one of the recent contributions of our machine age. Patent records on these machines indicate that it was not until about 1907 that this idea began to receive practical consideration. Since then some fifty patents have been granted on portable power saws, most of these relating to design details.

This article covers briefly some of the problems encountered while developing one of these power saws, one designed primarily for felling trees and for cutting them into required lengths—known as "falling and bucking." This machine is shown in action in *Fig.* 1, in the process of "bucking" a big log.

Important requirements which a designer must observe while developing one of these power saws are: Portability and maneuverability, simplicity, ruggedness, and safety.

Bear in mind that a power saw used for large-scale logging usually operates in mountainous country at high altitudes and often on steep grades. In addition, the ground may be covered with rocks, dead trees, and underbrush. Therefore it is essential that the machine be highly mobile. Also, once it is at the tree or log to be cut, it must be quickly adjustable to any height and to cut at any desired angle.

Operations usually are miles away from a repair shop and treefallers are not as a rule mechanically minded. Hence the saw must be as foolproof as possible and should require very little adjustment in the field. Unavoidable repairs such as a broken saw chain should be possible on the spot with a minimum number of tools.

The machine must be able to withstand rough usage and considerable abuse. Its engine must operate successfully under temperatures ranging from below zero Fahr. to as high as 110 degrees above. Lubrica-

tion must be automatic and at the same time as simple as possible.

Logging at best is dangerous work. Replacing the conventional cross-cut saw by a fast-moving, power-driven cutting chain obviously demands that controls both of engine and saw be centralized within easy reach of the operator. Furthermore, adequate guards and other safety devices must be provided but they must not interfere with operating efficiency.

The machine as it now stands after several years of development and trial, is made up of three main assemblies. These are:

1. The prime mover, which is a four-cylinder, air-cooled industrial-type Wisconsin engine, equipped with a Twin Disc clutch.

2. Saw mechanism proper, consisting of an endless cutting chain (see *Figs.* 1, 2 and 3) sliding on the edge of a bridge or guide plate and driven through a pin sprocket (see *Fig.* 3) and bevel gear reduction. This assembly connects with the clutch and engine through a swivel joint, details of which can be seen in *Fig.* 2.

3. U-shaped carrying frame, in which the engine and saw assembly are supported on a hoist as shown in *Fig.* 2, the whole mounted on rubber-tired wheels.

Selection of an air-cooled engine was prompted by these factors: First, the great range in temperature under which the saw must operate; second, the necessity for light weight; and third, desirability of as simple a cooling system as possible.

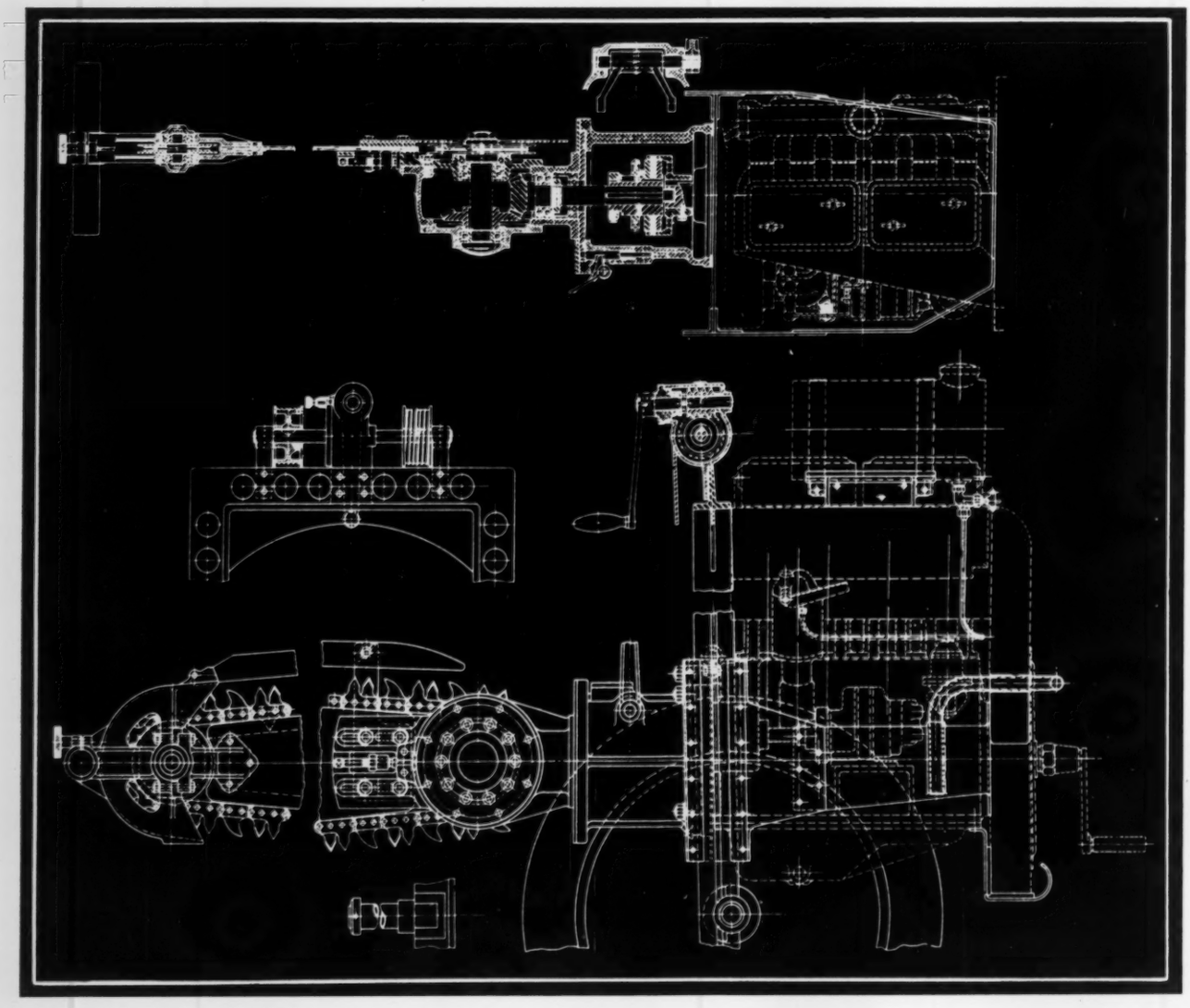
Until about a year ago the saw was powered with a two-cylinder motorcycle-type engine, rated about 18 horsepower at 3600 revolutions per minute. While this engine fulfilled weight and power requirements very well it had certain shortcomings.

The present four-cylinder engine, while somewhat heavier and theoretically of less horsepower than this two-cylinder engine, has better torque characteristics, even though it operates at less than half the speed of the earlier engine.

Combined with these advantages are easier starting, a simple lubricating system, a mechanical type governor, freedom from overheating and vibration, and a much lower upkeep.

The chain might well be termed the most important

Fig. 2—Assembly drawing of four-cylinder portable power saw, showing design of chain, swivel and hoist



member of the whole saw unit, since on its performance hinges the success of the machine. It is an endless chain ordinarily made up of 74 individual links, each of approximately 2-inch pitch. The names of the alternate members—cutter teeth and rakers—tell their purpose, one scoring the wood fibers while the other follows "chisel-fashion" and removes the chips, see *Fig.* 3. In service this chain is subject to severe strains through sudden jerks especially when the cut pinches the chain. It is designed to permit easy filing, set and swaging, which is necessary several times each week.

The most satisfactory chain material has been found to be standard band saw steel. The individual chain parts, that is, rakers, side links, cutter and sprocket teeth, are punched out. In order to save the dies from excessive wear, the material is worked in annealed condition. A typical analysis of this material is .75 carbon, .50 chrome, and .75 nickel. These chain parts require careful heat treatment. Maximum desirable hardness for soft wood cutting has been found to be about 48 Rockwell C.

Calculations Are Checked by Tests

If stress calculations alone were to be considered, this chain has a factor of safety of about 30. In spite of this conservative factor, however, the chains do break occasionally in service. In order to check the stress figure a number of chains made from different brands of saw steel were tested to destruction in a standard Olson testing machine. The breaking load varied between 7000 and 7600 pounds, corresponding to an ultimate breaking load of 164,000 to 170,000 p.s.i.

Shoulder pins holding the links together are made with a tolerance of .0005 inch on the diameter. Working clearance is on the center shoulder, while the ends of the pin are finished to a tap fit in the cutter teeth hole. The pins are casehardened and all pin holes are reamed to size.

The bridge plate on which the chain slides is built up of three plates riveted together, the center or filler plate being set back about ⅞-inch from the wearing edge. This provides a slot or guide for the sprocket tooth member of the cutting chain. In service this bridge plate is subject to severe twisting and bending, and it must be carefully assembled with special rivets.

Bridge plates are made of a high carbon, chrome alloy steel, heat-treated and with ground finish. Rivets are made of SAE 2315 steel.

As is obvious from *Fig.* 3, the chain is driven through a 2:1 bevel gear reduction and a ten-tooth pin sprocket. To minimize wear of the pins, and also to provide a smoother drive the sprocket is fitted with two ten-sided driving disks, one on each side of the chain. These engage the chain side links as they travel around the sprocket. The same design is carried out on the idler sheave at outside end of bridge.

Driving sprocket and idler sheave are built up of heat-treated tool steel plates where heavy wear occurs. Sprocket pins are casehardened alloy steel.

Since the saw must cut at any desired angle, a swivel joint is provided between the gear and clutch housing, a simple lock pin mechanism holding the saw bridge at the desired angle.

The hoist frame is made U-shaped in order that the saw can be lowered clear to the ground if necessary. Up-and-down adjustment of about two feet is provided through the two-cable hoist mechanism operated through a worm gear reduction, as shown by *Fig.* 2. This adjustment can also be used to help feed the saw while cutting.

The engine is hung in a cradle of welded plate. This is fitted with guide bars and moves up and down on the T-shaped side members of the hoist frame.

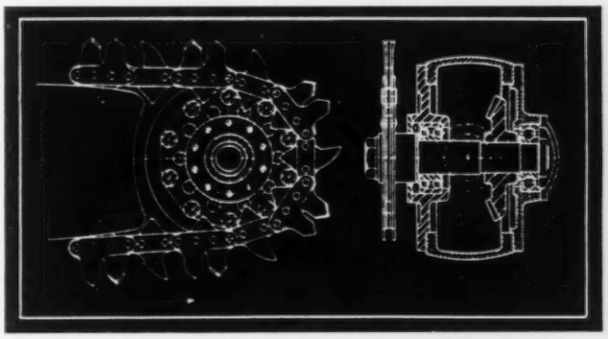


Fig. 3—Details of chain drive, showing how the ten-sided disks ease the load on the sprocket pins

In order to relieve the operators of unnecesary jolting and weight carrying while transporting the saw, the unit is balanced about its wheel axis. In other words the center of gravity of the engine and saw chain assembly falls on a vertical line intersecting the wheel axis.

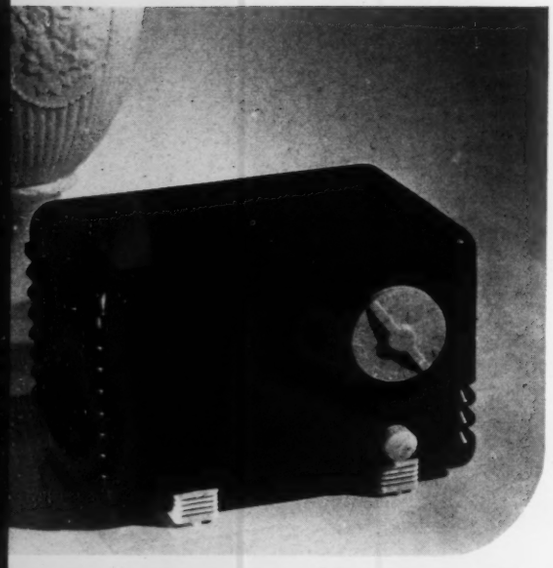
Wherever possible aluminum has been utilized in order to cut down weight. This applies to such items as engine oil pan, clutch housing, gear housing and covers, and exhaust manifold.

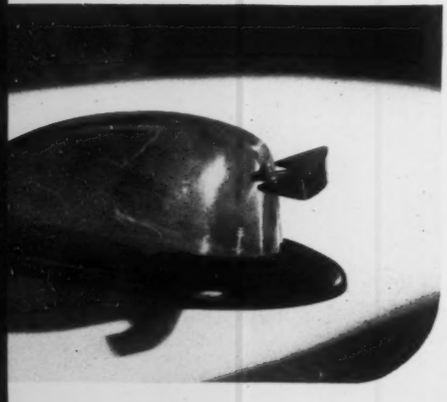
Lubrication has been made as simple as possible. Engine lubrication is taken care of by a combination splash and forced feed, and oil is circulated through the engine by a standard type gear pump. The clutch assembly and shaft bearings have a self-contained splash system, and any chance of leakage is prevented by a fiber seal ring grooved into the swivel plate. Bevel gear housing parts are lubricated with a light gear grease, and oil seals are used on both shafts.

At first the saw chain was lubricated from a built-in oil reservoir in the bridge plate. This proved to be an impractical refinement, however, and all chain lubrication is now taken care of by an occasional daubing with used crank case oil.

By J. Delmonte

Styling the Machine





Figs. 1, 2 and 3—Black phenolic plastic housing for adding machine has smooth velvety appearance yet retains high luster. Contrast of dark and light plastics is illustrated in radio which utilizes light urea plastic dials. Rich coloring is seen in the phenolic case of the stapling machine, left

TRANSFORMATION of an engineering design into a saleable machine is an art which relatively few have been able to master. In the past many machines or products did not enjoy the wide distribution that their advanced engineering features warranted, primarily because their external design features failed to create the desire of possession on the part of potential customers. Although engineers understand the importance of an acceptable operating performance, they frequently neglected to style the machine in keeping with high performance standards. Too often external features were decided upon in a hit or miss fashion, showing the need for an industrial designer to blend the engineering details with an "artistic" touch.

The last five years have witnessed a pronounced trend on the part of machine manufacturers to style their machines in an effort to combine good appearance with utility. This period has written a new chapter in the history of machine design, that in which styling becomes of prime importance. It is only natural that plastics, simultaneously rising to the fore as an engineering material, should influence designers in their selection of materials. Plastics possess those qualities that permit easy combination of beauty with engineering utility. Available in all conceivable colors, possessing a durable attractive finish, and pleasing to the touch, organic plastics have been adopted in the restyling of old machines and the design of new machines. So pronounced is this trend toward styling with plastics, that some of the larger manufacturers of plastics retain the services of industrial designers to cooperate with machine builders in restyling their machines.

SELECTION OF PLASTIC MATERIALS—In the selection of plastic materials for machine styling, the designer will find acceptable a larger number of materials than usually are employed solely for engineering purposes. The fulfillment of engineering functions as distinguished from external design purposes has fallen to relatively few plastic materials, notably molded and laminated phenolics, cellulose acetate, molded polystyrene, and molded urea plastics. The selection of these materials for engineering functions has been for the most part on the basis of their inherent properties. When attractiveness is the keynote, industrial de-

ne with Plastics

signers look to the following groups. (Color selection is indicated after each listing).

PLASTICS FOR DECORATIVE PURPOSES

Material	Color Selection
Molded Phenolic Plastics	Limited to darker opaque colors
Laminated Phenolic Plastics	Limited to darker opaque colors
Cast Phenolic Plastics	Unlimited
Molded Urea lastics	Unlimited
Molded Urea Plastics	Unlimited
Molded Cellulose Derivatives*	Unlimited
Laminated Woven Veneer*	Limited to veneer colorings
Sheets of Cellulose Acetate	Usually transparent—color unlimited
Casein Plastics	Unlimited
Vinyl, Acrylic, Polystyrene Resins	Unlimited

*Cellulose derivatives include the nitrates, acetates, cellulose ethers and mixed esters. Cellulose acetates predominate.
†Laminated woven veneers constitute strips of thin wood veneers woven into attractive patterns by hand and bonded together by a sheet of transparent cellulose acetate pressed together under heat and pressure.

A few explanatory notes upon each of the groupings in the above table would be helpful and would bring out distinguishing characteristics of each plastic. Electrical, mechanical, and chemical properties will not be compared in this article, having been dealt with in earlier issues of MACHINE DESIGN.

(a) MOLDED PHENOLIC PLASTICS—Though possessing a limited color selection, the phenol-aldehydic plastics find a more extensive application in machine design than other plastic materials. They are lower in cost and earlier in commercial origin, hence the subject of more development and research work. The molded phenolics offer large variation in property value, and therefore often combine engineering utility with beauty of finish. A typical unit employing a black phenolic plastic housing is the adding machine shown in *Fig.* 1. A lustrous, smooth finish and well rounded corners feature this design.

Not many phenolic plastics are molded in color because if color is desired the designer invariably turns to the more brightly colored plastics. There are exceptions, however, for rich maroon colored housings have appeared on several current machine designs, such as electric dry shavers and motor housings for vacuum cleaners. The dark, lustrous background afforded by a majority of molded phenolic plastics augments such decorative details as wiped-in enamel lettering, engraving on the plastic surface, or perhaps a minor design feature of contrasting color. Molded phenolic plastics are, therefore, not handicapped to any appreciable extent by their limited color selection, for there are always designs that are enriched by the stable, durable black finish. Besides, as noted above, it is always possible to enhance this finish by contrasting surface effects or contrasting colors. The radio cabinet in *Fig.* 2, molded of black Durez, with a urea plastic dial for contrast, illustrates this point quite clearly.

LAMINATED PHENOLIC PLASTICS—Laminated phenolic plastics, as well as molded phenolics, are limited in their color selection. When applied for decorative purposes, a paper base laminated material is generally employed to eliminate the probability of canvas and linen bases showing through the outside resin layer. Though lustrous black finishes predominate in the application of laminated plastics in machine and industrial designs, there are many dark color combinations and unusual effects possible with laminated phenolic plastics.

Contrasting Colors with Molded Phenolics

Contrasting surface effects attained in molded phenolic plastics are also obtainable with laminated materials. In addition, the laminated plastics have made appreciable headway with large metal inlays for decorative purposes. Metal inlays are possible in molded plastics, of course, but a large measure of success has appeared in the laminating of materials where the metal strips may be advantageously placed on flat surfaces.

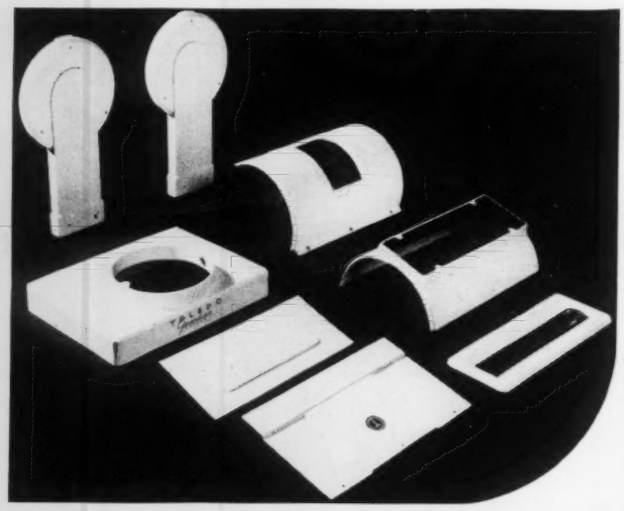
CAST PHENOLIC PLASTICS—The development of cast phenolic plastics, not of the permanently infusible and insoluble type, has made available to the designer a phenolic material of infinite color possibility and combination. Cast phenolics feature everything from transparent grades to mixed color types. In styling the machine with cast phenolics due consideration must be given to the method of manufacture before specifying these materials. The resin is poured into molds formed by steel arbors or dies about which a layer of lead has congealed. This naturally places a restriction upon the size, shape and accuracy of the cast piece and further machining may be required. A more finished product and more complex pieces are produced by pressure molding.

Small machine parts may be designed of richly colored cast phenolic plastics, such as the Hotchkiss stapling machine of *Fig.* 3. Long looked upon as an unattractive desk machine, the new unit designed with plastics boosted sales and won new friends by concealing the blunt skeleton-like operating mechanism. Gear shift knobs and clock cases are other instances of styling products with cast phenolic plastics.

MOLDED UREA PLASTICS—Probably next in impor-

tance to phenolics are the urea plastics. The delicate colors obtained with urea plastics have encouraged designers to introduce lighter colors in the styling of machines. Colors may be either translucent or opaque, as preferred. Control knobs on automobile dashboards and instrument panels are often of an attractive urea plastic color.

Molded urea plastics are widely popular because they offer not only beauty in enduring light colors, but also a great saving in weight. The latest model Toledo scale, designed by Harold Van Doren, achieves these results with distinction. Instead of a large, single molded housing, the units are built up of seven or eight sections molded of white urea plastics and



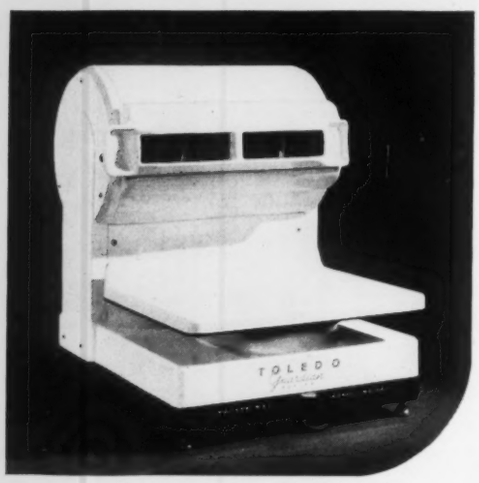


Fig. 4—Eight molded urea plastics are assembled about a die-cast frame to make an extraordinarily light and beautiful scale

assembled about a die-cast frame. The molded pieces and the assembled scale are shown in *Fig.* 4. Earlier models which did not have plastic housings weighed 160 pounds, as compared to the new 58-pound model. A total of ten pounds and two ounces of urea formaldehyde plastics is employed in each unit.

Small moldings of urea plastics have also been used extensively in decorative knobs, handles and controls for contrast as well as utility. The plastic does not necessarily have to monopolize the whole design in order to be effective in restyling; small well-placed units often give a finished appearance to the design.

LAMINATED UREA PLASTICS—Though the applications of laminated urea plastics to the styling of machines have been relatively limited, the materials have attractive features not to be overlooked. From the experience with laminated phenolics, one would judge that laminated ureas are suitable for panels, nameplates, and translucent members to achieve certain lighting effects in applications such as radio dials, etc.

MOLDED CELLULOSE DERIVATIVES—For years molded nitrocellulose products and shellac resins dominated the industrial applications of thermoplastic materials. With the development of flameproof cellulose acetates and mixed cellulose esters, the nitrocellulose was accorded a secondary position as a moldable plastic material. Shellac, by reason of certain electrical qualities, fulfills specialized engineering purposes. Cellulose acetate, on the other hand, has played an important part in styling the machine with plastics. Available in an unlimited color selection, the cellulose acetates are fully as satisfactory in this respect as cast phenolics and urea plastics.

Cellulose Acetate Is Readily Molded

Thermoplastic cellulose acetate is readily molded by injection methods and capable of reproducing with great accuracy the fine details of design inscribed within a mold cavity. The excellent flowing qualities of the material and the technique of injection molding permit: molding very thin sections; reproduction of decorative design details; and molding over metal, wood, or rubber cores. The molding of cellulose acetate over metal cores combines decided mechanical advantage with improved styling efforts.

Molding material in these cases may be transparent or opaque, as desired. This technique suggests applications to machines of different colored plastics for operating levers and control knobs to facilitate easy identification. At the same time a harmonious blend with the housing may be obtained. Designers find that combined metal and plastic parts do much to improve the appearance of a particular unit. This combination is readily possible with injection molded cellulose acetates.

The size of pieces reproduced by injection molded methods has, up to the present, been limited by the capacity of injection molding equipment. The trend toward 16 and 32-ounce capacity machines is an incentive toward the production of larger housings by injection methods, making available the tough, flexible, shock-resistant cellulose acetates for larger

machines. There are, nevertheless, attractively styled injection molded housings for smaller machinery.

LAMINATED WOVEN VENEER—There have not been many commercial efforts to laminate thermoplastic materials analogous to thermosetting laminated types, but rather the designer has relied upon sheet stock of the materials. One interesting method, recently developed, which is described as laminating of thermoplastic materials, introduces to the industry a product designed solely for appearance. Mechanical qualities could be achieved more economically in other conventional manners. The laminated woven veneers do possess, however, singular characteristics. Many attractive patterns may be attained by hand weaving of thin strips of wood veneer, bonded together under heat and pressure by an applied layer of transparent cellulose acetate. The tightly woven wood veneers stiffen and reinforce the thermoplastic material.

Transparent Cellulose Acetate Available

CELLULOSE ACETATE SHEET AND EXTRUDED STOCK—Sheet stocks of cellulose acetate are available in various colors and grained effects. This stock may be formed into large curved areas where plain surfaces and uniform thickness are desirable. This allows the designer to specify, economically, panels of plastic sheet stock on the outside of some machines in lieu of an expensive large molded housing. Transparent plastic sheets have good clarity and flexibility and also provide a good subject for machine stylists. A strong, flexible transparent sheet can fulfill many purposes, and opens up a new approach to styling methods, inasmuch as internal parts and mechanisms may be displayed to good advantage. Colored with some dye, they are also useful in providing a means of obtaining certain design effects.

Extruded stock of cellulose acetate and other thermoplastic materials will be of increasing importance as designers begin to include larger areas of plastics in styling machines. Long continuous lengths of uniform cross section are made by extrusion. This includes sections that could not be readily formed by molding operations, such as those with undercuts. Machine designers can expect an increasing use of extruded plastics in the styling and construction of machines.

CASEIN PLASTICS—Though primarily for buckles, buttons and small decorative items, casein plastics represent a group of materials whose chief distinctions are good color selection from tube, bar or sheet stock, and economical production. Casein plastics are not moldable and must be machined from stock. There are miscellaneous accessory parts on machines for which casein plastics can be considered, along with other plastics, for decorative touches in styling.

VINYL, ACRYLIC, AND POLYSTYRENE RESINS—Though vinyl, acrylic, and polystyrene resins have been used in the design of some machines because of certain outstanding physical, chemical or electrical properties, they have experienced relatively little progress in restyling machines. This may be attributed to two reasons: Lower cost of competitive materials and comparative newness of the acrylic, vinyl and polystyrene synthetic resins. They are available in transparent forms, and with the exception of the vinyl resins, there has been little effort, so far, to introduce color effects into industrial materials of this type due to the lack of demand. These resins may be molded

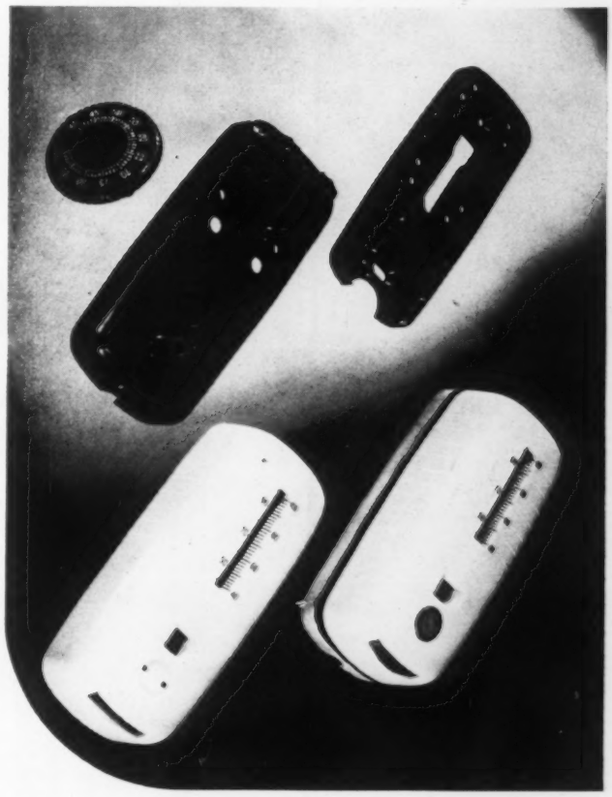


Fig. 5—Outside housing of temperature control thermostat is injection-molded cellulose acetate. Base and control whee are dark-colored phenolics

or fabricated from sheet stock. Formed sheets of the transparent methyl methacrylates already are known to industry for their optical clarity. They have been used quite extensively over airplane cockpits and about the observation compartments of newly designed aircraft.

Polystyrene has had little to do with styling efforts, though it is of major consequence to certain electrical apparatus. Thermoplastic in nature, it likewise must be included as a possible material in styling the machine, particularly electrical apparatus.

COMBINATIONS OF PLASTICS—A home temperature control thermostat unit, styled by Barnes & Rienecke, illustrates an effective and attractive combination

of plastics. The component parts are illustrated in *Fig.* 5. The outside housing is injection molded of ivory colored cellulose acetate, while the base and temperature control wheel are of dark-colored phenolic plastics.

PRINCIPLES FOR STYLING MACHINES WITH PLASTICS—At the beginning of this discussion it was implied that a certain technique was required to produce acceptable results. This technique, like any other skillful art, must be acquired from training and be matured with experience. Machines followed heavy conventional lines for years, fulfilling the demands of a small and stable market, but little effort was made to create new interest and new sales. Not until the inception of carefully planned decorative treatment, combining utility with qualities of display, did the machine experience a rebirth.

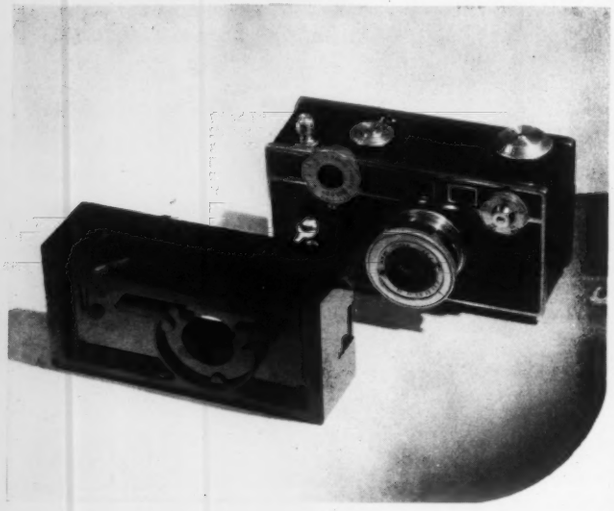


Fig. 6—Stipple front face of molded plastic camera case and glossy sides give unusual effect

In those cases where an industrial designer or stylist is engaged, close cooperation between him and the engineering department is certain to produce the most satisfactory results, provided both parties do not place too great a restriction upon the other person's specialized abilities. The industrial designer will start with crude rough sketches of the machine and follow through to models of the final design. Principles that are observed in styling the machine are particularly adaptable to plastics, and decidedly functional in purpose. Some of the principles are given below for illustrative purposes, and their direct bearing upon plastic materials are pointed out.

(a) *Streamlining*—Five years after the popularization of the expression "streamlining" through the media of streamlined trains, aircraft, and automobiles, the term became a household name. Immobile products and machines have followed the streamlined style trend. It can of course, be overdone, but if correctly proportioned is of advantage. The production of streamlined housings of plastics is an asset to hot molding operations. It will be remembered that well-rounded corners and fillets are keynotes to successful moldings, and hence streamlining fulfills one of the basic principles of the design of molded plastic parts.

Streamlining conveys an impression of symmetry and lightness, which in fact is achieved readily through molded plastic housings. It represents an abrupt departure from the rough cubical contours that featured earlier designs of machines. A striking example of the use of plastics in streamlining is shown in *Fig.* 7. The Hoover vacuum cleaner attracted much industrial interest through its extensive use of plastics and magnesium alloys to reduce weight. A molded plastic housing augments the appearance of the unit.

Special Effects Reduce Monotony of Flat Surfaces

(b) *Treatment for Flat Surfaces*—Large, flat areas give the onlooker an impression of concavity, and are generally avoided in styling the machine with plastics. One method of treatment is the provision of a certain amount of convexity to offset the illusion of concavity. The surface is usually curved so that the high lights reflecting from the surface will emphasize luster. An impression of waviness is sometimes given by large flat surfaces. Domed-shape, rather than flat tops, are much to be preferred for molded box covers or molded housings, as the appearance is not only improved but the mechanical strength and flow qualities of the molding powder are considerably aided.

(c) *Control of Highlights*—In styling a machine it often becomes desirable to locate highlights to the best advantage, or to increase the number of areas of reflection. This may be achieved practically by a series of steps, forming different planes upon the surface, usually not exceeding 1/64th of an inch at the step. Such a change is relatively simple to produce in a mold for plastic materials. This procedure gives the observer an impression that several pieces contribute to the unit and detracts from the monotony of a flat plastic surface upon which decorative scrolls or inlays would not be feasible.

(d) *Sturdiness in Appearance*—In machine design it is particularly desirable to create the impression of solidity and sturdiness in appearance. This factor is often conveyed by using a base of dark colored plastic, and a housing of lighter shade material. Where size and volume leave little doubt of the sturdiness of a unit, this principle may not be so important. However, it does give a psychological lift to a relatively small molded product.

(e) *Concentric Ribs on Flutes*—The engineer looks

upon ribs as stiffening members, capable of applying rigidity to some weak structure. When molded externally upon some plastic housing they are often intended for concealing flow lines in the molded housing. Thrown out in a relief against a satin-finished background, the ribs or flutes will also achieve rich decorative effects.

(f) *Unity of Design Features*—In styling a machine, especially the side upon which the control knobs and dials might be placed, it is good practice to bring all the controls under the intelligence of the eye. Too often dials and knobs indiscriminately placed upon panels are looked upon as separate entities, whereas they may all be cooperating toward the same purpose. It may be desirable to bind the units together by the simple expedient of running a line of contrasting color from one dial to another. A certain amount of discretion must be given this procedure in styling machines, because dials and knobs may be too far displaced from one another, and the small narrow lines detract from other decorative features. However, on smaller units the lines tend to draw the attention of the eye from one unit to another.

Larger Plastic Moldings in Future

(g) *Contrast Effects*—For contrast effects of the same material such as black rather than by varying colors, different surface treatments may be employed such as a stipple finish and glossy surface. A stipple front face and glossy sides are shown in *Fig.* 6, a molded phenolic plastic housing for a candid camera.

Methods and the technique of molding large plastic surfaces are a matter of some conjecture for the future. Molding from powders to form panels that are assembled together has certain advantages in the event of complicated pieces, though the additional mold costs will represent an appreciable investment. There are, however, molding or forming techniques which warrant the attention and encouragement of the machine builder—those of forming large generously curved sections from molding boards or semi-cured, canvas base, laminated plastics. Both of these materials are strong and impact-resisting in final form and have little to limit their size. Present large hydraulic presses are capable of forming sheets as large as 120 x 72 inches and there is no reason why the platen area could not be increased if the demand exists. Direct transfer of semi-cured laminated phenolic sheets, while still hot, to a large forming die appears to be one approach to the manufacture of large plastic panels. Shrinkage and warpage may have to be overcome by a gradual reduction in temperature from the molding temperatures. These methods will be undergoing commercial development in the next few years, instigated primarily by the manufacturers of automobiles and aircraft. At the time of writing, governmental agencies are investigating experimental fabricated plastic airplanes. The first of these may not be successful, but the potentialities are enormous.

Fig. 7—Plastics and magnesium-alloys are used in this streamlined vacuum cleaner to reduce weight. The design represents abrupt departure from the square corners of a few years ago

Correlation of style trends with plastics will have an important bearing upon external design of machines. Improvements in performance are also heralded emphatically by improvements in appearance. The styling of a machine should in no whit suggest an attempt simply to conceal the mechanism or to effect a minor redesign for change, but should be fully in keeping with high performance standards to which the machine is built.

Other articles on plastics by Mr. Delmonte which have appeared in recent issues of MACHINE DESIGN may be found in the October and November, 1937 issues, and in the January and May, 1938 issues.

Lead Used for Soundproofing

A comparatively little known application of lead is for sound proofing. Lead, by virtue of its natural characteristics occupies a position of ever-increasing importance in this field. An excellent example of how sheet lead solves the exacting problem of sound insulation is found in the General Psysiological Laboratories of the Sorbonne, famous French university. It was necessary to insulate the laboratory from all outside disturbances so that energy sources within might be accurately determined. The rooms were entirely lined with sheet lead 0.06-inch thick, equivalent to a four-pound lead. This lining was applied directly to the floor and was screwed to the walls and ceiling. All joints were soldered to avoid breaks in continuity and special precautions were taken to insure adequate soundproofing of doors and door knobs. Tests showed the problem satisfactorily solved.

Automatic time control keeps frozen ice cream always ready for serving in the Taylor Freez-matic, above. Aluminum base supports 1/6 horsepower motor which beats and aerates cream. Larger motor in base drives compressor through V-belt

All blades in the U. S. Slicing Machine's Model MB bread slicer, right, are out of sight and so placed that operator's hands cannot become entangled. Mechanism is entirely enclosed and entire machine occupies only 22 x 15 inches on counter

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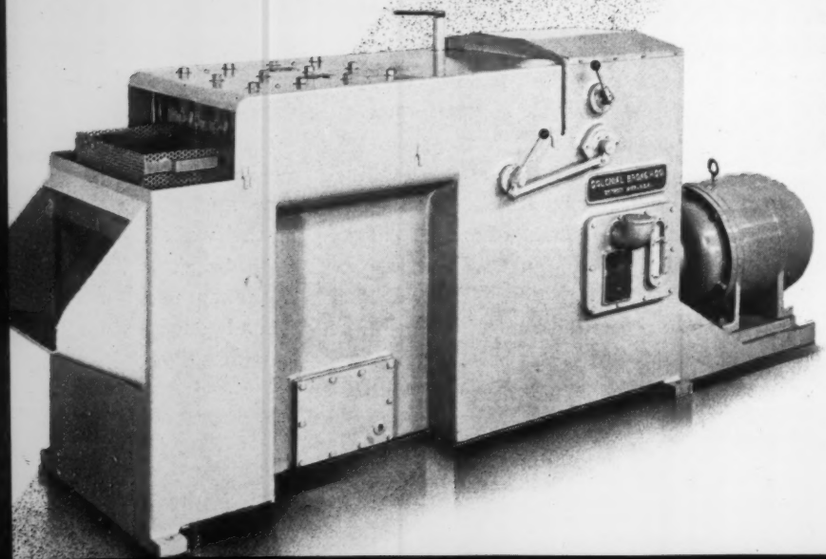
Almost entirely enclosed and completely automatic in operation, Colonial high speed horizontal hydraulic broaching machine, below, has maximum capacity of 3600 pieces per hour. Broaches are stationary in machine, work being pushed through for an 18-inch stroke



Heat exchanger tubes of the Bryant gas heater, above, are of chromium steel; combustion chamber is cast iron. Thermo-pilot, built-in draft diverter make heater completely automatic. Blue crackle finish jacket houses tubes and burner and gives unit neat appearance

Cabinet type base of the U. S. Multi-Miller, right, houses coolant tank, pump, and spindle and feed driving motors. Machine is equipped with a pressure oiling system for lubricating all moving points. Both conventional and climb milling may be performed on the machine

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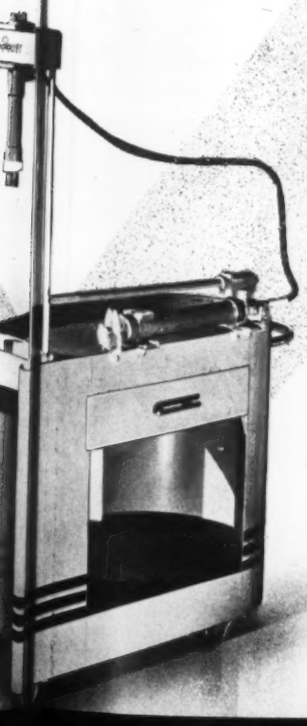
**Presentation of Recent Ma-
m the Standpoint of Design**

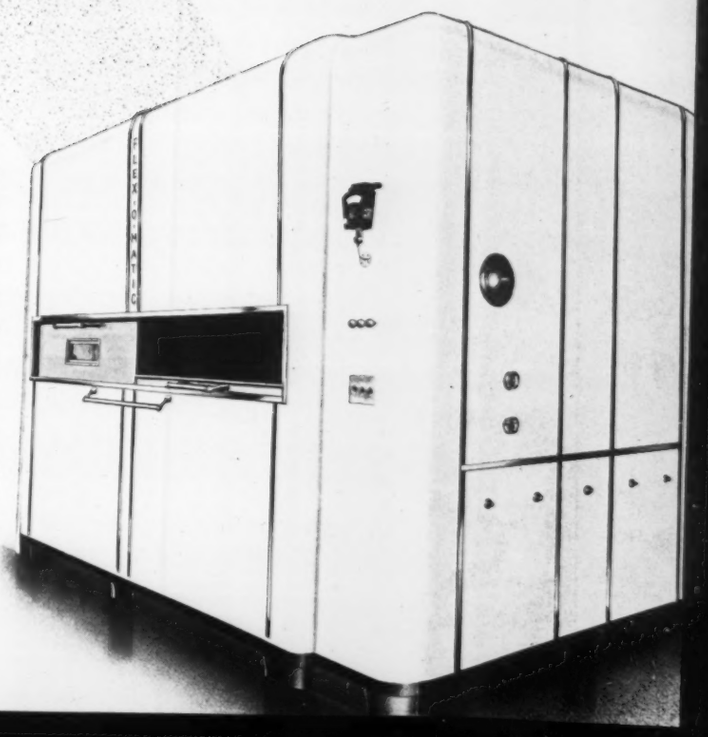
new machine listing see page 80)

Black plastic case with varicolored vanes blended together produce striking effect in Pennwood Imperial model clock, left. Small, self-starting synchronous motor drives four die-cast drums mounted on metal chassis, giving time in hours, minutes and seconds



Rounded corners give a pleasing appearance to the Union Steel Product Flex-O-Matic oven, right. All controls, with the exception of steam valves, are located on the front of oven. Six inches of fiber glass blankets the baking chamber against loss of heat and provides a lifetime insulation

Rolled steel body on the Blackhawk Porto-power hydraulic repair machine, left, styled by Barnes & Reinecke gives distinctive appearance. Ram supports and push bar are chromium plated for corrosion resistance and to produce bright finish



Due Credit Is Accorded Designers For Amazing Achievement

WHEN the time taken for a record-breaking performance cuts in half the previously-held record—that's headline news. Consequently it is common knowledge that such a feat was accomplished by Howard Hughes in his recent 'round-the-world flight. Wiley Post's memorable solo flight five years earlier took slightly more than twice as long.

The latest record places Hughes in a class all his own. Not only by his having achieved his ambition is this the case, but because he modestly minimizes his performance and that of his associates on the flight, giving full credit instead to the designers of his machine. To quote him: "Any one of the airline pilots . . . . . could have done the same thing. If credit is due anyone, it is due to the men who designed the modern American flying machine."

Unfortunately it is not often that designers hear their work praised in this way. For some reason manufacturers of certain types of machines have in the past been reticent in permitting, for instance, the name of a designer to be coupled with what might be an outstanding development. But that this feeling is changing is becoming increasingly evident, it now being realized that in all record-breaking performances in which machines play their part, a triumvirate is involved—the designer, the operator and the machine.

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Interest in Materials Sweeps On!

THAT MACHINE DESIGN'S Directory of Materials has established itself in the minds of designers as a noteworthy contribution to engineering literature has been amply proved by the acceptance of each edition as published. Orders for reprints of the Fifth Edition, which was included with the October, 1937 issue, have surpassed all expectations, with the result that a decision has been reached to publish a Sixth Edition with the forthcoming October number of the magazine.

Increased demand for each succeeding issue of the directory clearly confirms the trend toward "materials consciousness" on the part of engineers charged with responsibility in design. Further, it connotes the alertness with which designers seek information on the latest available materials for improving their machines.

The sixth edition of the directory will be superior to earlier editions in several respects. Current listings of iron, steel and nonferrous alloys, plastics and other nonmetallics will be revised and brought up-to-date with additions, as also will be the listings by companies, and four new, complete sections will be included giving the company names, facilities and other pertinent information on die casting companies, forgings producers, stampings producers and custom molders.

Men of Machines

NAMING of F. Ellis Johnson, formerly dean of the engineering school at the University of Missouri, to head the University of Wisconsin's college of engineering has recently been announced.

After graduation Dean Johnson became connected with power plant construction in the Pacific Northwest, later becoming consulting engineer. In 1912 he was appointed the first engineering instructor at the Rice institute, and three years later became connected with the University of Kansas. He remained there fifteen years, first as instructor and finally as head of the department of electrical engineering. From 1930 to 1935 he was head of the electrical engineering department at Iowa State college, at the end of which time he became dean of the University of Missouri's college of engineering.

F. ELLIS JOHNSON

• • •

ACTIVE in the American Society for Metals since its organization, William Park Woodside, vice president in charge of research, Climax Molybdenum Co., has been made president. He organized the first Steel Treaters' society in 1913, later called the Steel Treaters' Research society. From this group the Chicago chapter withdrew and formed the American Steel Treaters' society, later merging with Steel Treaters' Research society and becoming the American Society for Steel Treating, now known as American Society for Metals.

From experiences such as his 4-year toolsmith apprenticeship; his associations with Cadillac Motor Car Co.; with Crucible Steel Co. where he aided in introducing alloy steels; and later, in Studebaker's forge shop and heat treating plant, Mr. Woodside acquired extensive knowledge.

WILLIAM P. WOODSIDE

• • •

SINCE 1920 professor of mechanical engineering at Johns Hopkins university, Alexander Graham Christie has been nominated for the office of president of the American Society of Mechanical Engineers.

Professor Christie was born in Manchester, Ont., Canada, in 1880, and was graduated in 1901 from the School of Practical Science, University of Toronto, receiving his mechanical engineering degree in 1913. He started his engineering career in 1901 as mechanic at Westinghouse Electric & Mfg. Co., working his way up to be a figure in the early development and construction of steam turbines and gas engines. In 1904 he resigned to become an instructor in mechanical engineering at Cornell university, resigning again the following year to take charge of the erection, test and operation of the first steam turbine built by Allis-Chalmers

ALEXANDER G. CHRISTIE

Co. His further work here was also in connection with condensers, steam engines, gas engines and pumps.

After two years in the power plant field Professor Christie was, in 1909, invited to become assistant professor of steam and gas engineering at the University of Wisconsin, later becoming associate professor. Five years later he joined the faculty of Johns Hopkins university as associate professor of mechanical engineering and was promoted in 1920 to a full professorship.

♦ ♦ ♦

A. T. KELLER, chief engineer of construction of Bethlehem Steel Co., will retire from active service on Sept. 1—this after fifty years of service in the steel industry. He will be succeeded by R. B. GERHARDT, who is now assistant chief engineer of construction. G. S. COMSTOCK has been appointed to assist Mr. Gerhardt.

♦ ♦ ♦

JAMES W. PARKER has been elected president of the Engineering Society of Detroit. He is vice president and chief engineer of Detroit Edison Co., and vice president-elect of the American Society of Mechanical Engineers.

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CARL ZAPFFE JR. has been appointed research associate at Battelle Memorial institute, Columbus, O.

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ALLAN W. FRITZSCHE of General Industries Co., Elyria, O., was unanimously elected president of the Society of the Plastics Industry at the annual meeting. WILLIAM KELLY of Chicago Molded Products Corp., who has been secretary-treasurer since inauguration of the society, was re-elected.

♦ ♦ ♦

ROBERT LEMUEL SACKETT, from 1915-1937 dean of the school of engineering, Pennsylvania State college, has been awarded the Lamme Medal of the Society for the Promotion of Engineering Education. Dean Sackett, since retirement, has devoted himself largely to the work of the Engineering Council for Professional Development.

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T. G. DELBRIDGE, manager of the research and development department Atlantic Refining Co., has been elected president of the American Society for Testing Materials.

♦ ♦ ♦

DR. JOHN C. PARKER, vice president of Consolidated Edison Co. of New York, has been elected president of the American Institute of Electrical Engineers. A detailed account of Dr. Parker's career appeared in the April, 1938 issue of MACHINE DESIGN, at the time of his nomination.

♦ ♦ ♦

DR. C. F. HIRSHFELD has been granted the honorary degree of doctor of engineering by the University of Detroit. Dr. Hirshfeld is chief of research, Detroit Edison Co., and past chairman and member of Engineers' Council for Professional Development.

♦ ♦ ♦

EDWIN L. LARSON has been appointed assistant sales manager of the machine tool division of Van Norman Machine Tool Co., Springfield, Mass. Mr. Larson formerly was chief engineer of Baush Machine Tool Co. For two and one-half years prior to his present appointment he was connected with the Van Norman engineering department.

♦ ♦ ♦

H. B. DU PONT, connected with the engineering department of E. I. du Pont de Nemours & Co., Wilmington, Del., has been appointed assistant to the president to succeed the late B. Dorrance Beyea.

♦ ♦ ♦

ALFRED H. R. FEDDEN, chief engineer of the Bristol Aeroplane Co. Ltd., Bristol, Gloucestershire, England, has been awarded the Daniel Guggenheim Gold Medal "for contributions to the development of aircraft engine design and for the specific design of the sleeve-valve aircraft engine".

Obituaries

GEORGE E. EMMONS, formerly manager of the Schenectady works of General Electric Co., and later vice president in charge of manufacturing for the company, died July 1.

♦ ♦ ♦

EDWIN J. BELL, a well known inventor and president of the Bell Machine Co., Oshkosh, Wis., died at his home at Pau-Ko-Tuck, Wis., at the age of 65. Mr. Bell was a recognized authority on match-making and woodworking machinery, and was invited to go to Great Britain as a consulting engineer to the United Match industries in 1930. Since 1911 when he entered the machinery business, he had invented and designed more than 150 machines.

♦ ♦ ♦

CLARENCE M. RUDEL, retired president of Canadian Vickers Ltd., died in Montreal, Que., Canada, June 21.

♦ ♦ ♦

FREDERICK WINTHROP NEILSON, 42, formerly president of Sikorsky Aircraft Co., Stratford, Conn., died recently.

NOTEWORTHY PATENTS

LEONARD O. CARLSEN of Rochester, N. Y. has developed an indexing mechanism which is said to combine relatively noiseless operation with positive action and long life. This device, which is shown herewith in *Fig.* 1, is covered by patent No. 2,088,687, assigned to Gleason Works of Rochester.

The mechanism is built around a notched index plate for securing to the work spindle of the machine, which in the case illustrated is a gear-cutting machine. Pivoted within the guard is a lever carrying a locking dog which engages the notches in the plate to hold the work spindle against rotation during the cutting of the gear teeth.

Rotatably mounted on the work spindle is another arm to the end of which a pawl is pivoted. This pawl is designed to engage the notches of the index plate and to rotate it when the locking dog is out of engagement. The pawl is constantly urged towards its operative position by a spring-pressed plunger. This plunger is housed in a recess of the arm on the spindle so that it engages the tail of the

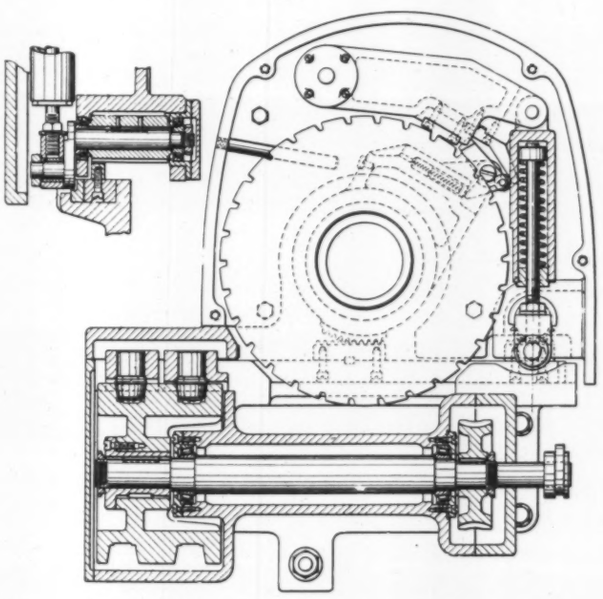


Fig. 1—*Indexing mechanism, designed for gear-cutting machines, operates silently and automatically*

pawl. As long as the locking dog is in inoperative position the pawl is held out of engagement with the index plate by a cam plate on the lever. This engages a roller carried by the pawl.

The locking dog is moved to and from operating position by oscillation of a crank to which it is connected by a spring plunger member, details of which are shown by the supplementary view. This oscillation is effected by means of a rack on a drawbar which is actuated through a lever from one track

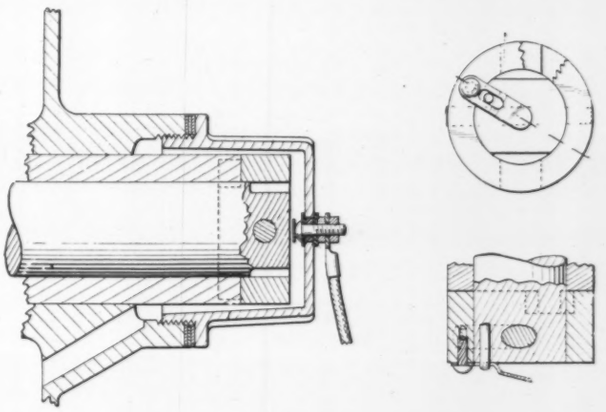


Fig. 2—*In case the driving pin shears off, displacement of spring breaks contact and sounds alarm*

of a double-tracked cam drum visible at the left in the diagram.

The other track serves to actuate another sliding bar carrying a rack that actuates the pawl arm on the spindle. The cam lever of this last-mentioned linkage has an adjustable fulcrum by which the stroke of the rack bar can be regulated. The shaft carrying the cam drum is coupled to, and driven in time with, the operating mechanism of the gear cutter.

Gives Alarm When Pin Shears

DEVELOPED particularly for use on mechanical stokers, but with possibilities in many other directions, a shear pin alarm system has been invented by Robert W. Suman. This is covered by patent No. 2,113,666, assigned to Link-Belt Co., Chicago.

When applied to a stoker this system gives instant warning of the shearing of the pin connecting the slow motion shaft which operates the screw conveyor and the gear reduction mechanism. This insures that the jammed conveyor can be cleared and the shear pin replaced without loss of time.

The illustration, *Fig.* 2 depicts a longitudinal section through the end of the slow motion shaft, together

with an end view of the alarm device. In action the shear pin collar is driven from a sleeve through clutch teeth, the collar in turn driving the slow speed shaft through the shear pin.

A contact spring is screwed to the shear pin collar so that normally it assumes the radial position shown in the cut. However, if angular displacement occurs between collar and shaft, as happens when the pin shears, the alarm control pin in the shaft acts on a slot in the spring to swing the spring out of its radial position.

A hub cap which is threaded in the bearing sleeve encloses the end of the shaft and the shear pin collar. At the center of this hub cap is a contact screw insulated from it by non-conducting washers. Ordinarily this is in contact with the spring, keeping an electric circuit closed during normal operation. If the pin shears however, the spring is displaced, breaking the circuit, sounding an alarm, and—if desired—stopping the driving motor.

Press Has Ball Bearing Thread

FOR the purpose of obtaining extremely large multiplication of force without undue friction, John Jensen of Rockford, Ill. has invented the ingenious type of manually-operated pressure tool shown by *Fig.* 3. This is covered by patent No. 2,113,087, assigned to the Whitney Metal Tool Co. The tool illustrated is

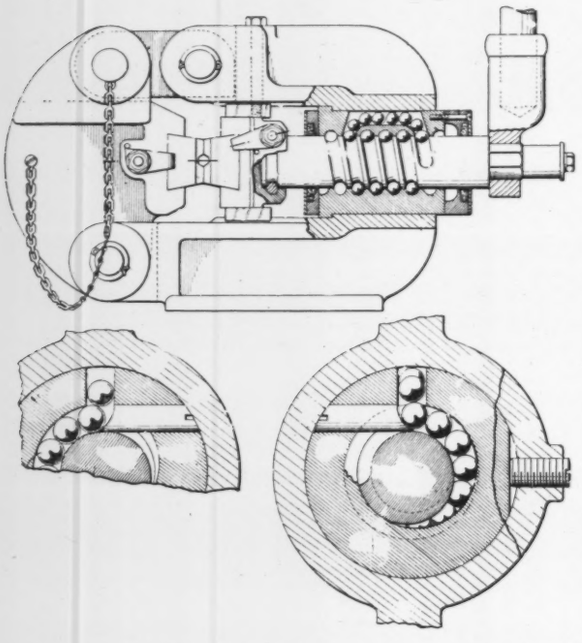


Fig. 3—Hardened steel balls insure free action between screw and nut of manually operated press

designed for the pressure-splicing of wire by use of a connector sleeve.

The interesting feature of the invention is the anti-friction gearing employed to move the right-hand die toward and away from the fixed left-hand die. This consists of a pair of telescoping members having a series of hardened steel balls engaging both members in such a manner as to form the equivalent of a smooth-running screw thread between them. In other words, this is a ball bearing screw thread.

It will be noted from the drawing that spindle and sleeve have compliementary spiral channels shaped to

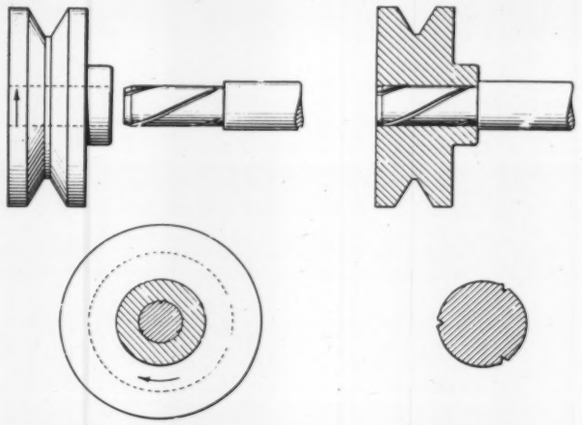


Fig. 4—Incised spiral grooves provide non-slipping fit when shaft is pressed into bored hub

fit the balls. Jamming of the balls as they approach the ends of the spiral grooves is prevented by an arrangement which ejects the balls at one end of the track and returns them to the other end. As the spindle is rotated clockwise the balls are directed from their spiral track by the curved inner face of a dog in the transfer passage. This dog consists of a tangential pin with a curved end. The dog or pin has a counterpart at the other end of the passage, which guides the balls back into their spiral track, in the manner which is clearly indicated by the two supplementary views in the lower part of the cut.

Spiral Insures Driving Fit

WILLIAM S. LEFFLER of New York has been granted patent No. 2,119,334, covering what he calls a "self-affixing and self-tightening connection for rotating and rotated members." This system, as applied to a small pulley for round or V-belt, is clearly depicted by *Fig.* 4.

The patent describes a system of tools by which spiral incisions are rolled into the shaft (as shown) or into the bore. It should be observed that in making these incisions, metal has not been removed. It merely has been displaced in the form of ridges alongside the incision.

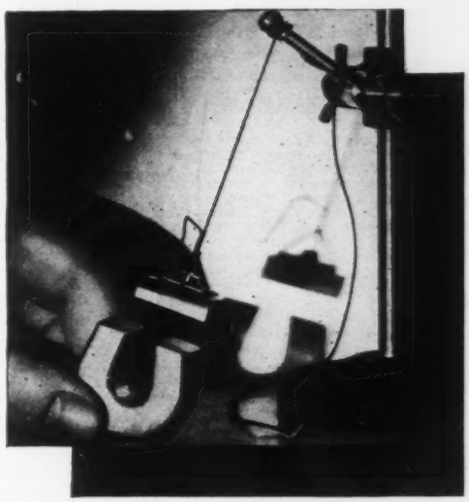
When the spirally incised shaft is pressed into the bore there is some effect toward channeling the bore, at the same time toward forcing the displaced metal into the groove. Thus the two parts are locked against rotation one on the other.

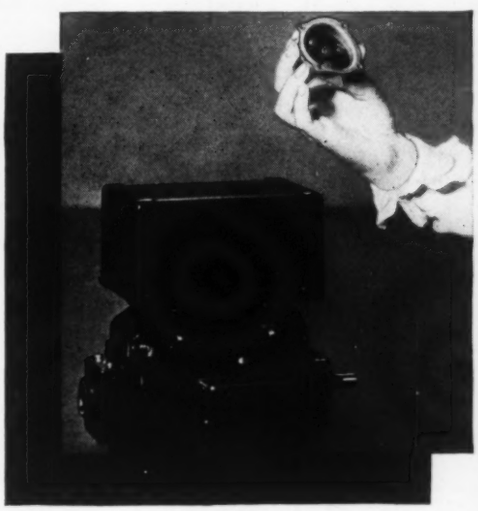
HIGH NICKEL ALLOYS

RAISE EFFICIENCY AND LOWER COSTS

...in scores of special applications

HIGH MAGNETIC QUALITIES... The magnet pictured here is small, but extraordinarily powerful—capable of lifting 60 times its own weight. This particular type, made of a new alloy rich in Nickel, is used for damping magnets in the polyphase meters of the Duncan Electric Co., Lafayette, Ind. Not only do these alloys of high Nickel content effect substantial savings in weight (in this case 80%) but they also have a higher permanency factor than other commercially available magnetic materials and are practically immune to the effects of magnetic disturbances caused by short circuits and lightning. Manufacturers who employ magnetic materials in their products will find these new alloys of Nickel profitable to investigate.





HIGH AND LOW EXPANSION PROPERTIES...

One of the most valuable metallurgical developments in recent years has been the production of thermostatic metals for operating automatic control devices. Pictured here is one employing a bi-metallic disc made of two alloys of Nickel, one having a high degree of expansion and the other low expansion properties. It guards the Westinghouse refrigerator motor, disconnecting it when it gets too hot and reconnecting it when it cools off. Principle upon which these thermostatic metals operate is based on a differential in the expansion properties of the two constituent metals. Changes in temperature cause them to deflect and this in turn acts on the control device. Alloys of Nickel can be produced for applications requiring extremely low expansions as well as for service where specific expansion characteristics may or may not be low.

IMPROVED PERMEABILITY... When you make your long distance telephone call or send a cable, a highly magnetic Nickel-Iron alloy of improved permeability containing up to 80% Nickel helps to deliver your message. Impulses sent over long circuits have a tendency to drag their "tails" behind them, upon which succeeding impulses tread. But through the use of loading coils made of a high Nickel alloy, and spaced at regular intervals along the circuit, transmission is speeded up and your words made intelligible. The high magnetic permeability of these alloys is also depended upon to increase the efficiency of submarine cables and various parts of radio, telephonic and telegraphic installations. We invite consultation on the use of the Nickel alloys in your equipment.

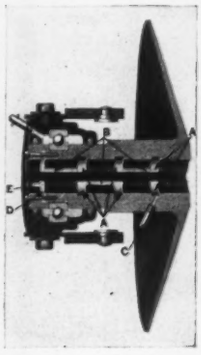
THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK, N.Y.

Q. Can we depend upon the Lewellen Lubrication System?

A. (Note: This question is answered in the words of engineers and superintendents using Lewellen Variable Speed Control). **"Only the failure of the oiler to perform his duty can result in trouble from the Lewellen Lubrication System." "We like its simplicity. There is only one Alemite connection to lubricate the disc hub, keys and shafts." "After a thorough inspection, we installed Lewellen Transmissions because we were sold completely on the Lewellen Lubrication System."**

THE LEWELLEN SYSTEM OF POSITIVE LUBRICATION

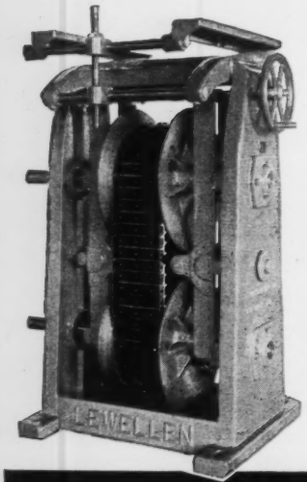
In the bore of the disc hub is a series of lubricant grooves "A" connected by channels "B" on alternate sides of the key, making one continuous lubricant channel. Grease enters at Alemite connection "C," and is forced through this groove around the shaft to the first channel which carries the grease to the second annular groove. Again it passes around the shaft to the next channel which is at the opposite side of the key. This process is continued until the grease has passed around all the grooves, finally reaching the space at "D" where it again passes around the shaft and out at hole "E."



These annular grooves are so spaced that only a small movement of the disc upon the shaft is necessary in order to completely lubricate the disc and the shaft. When an operator applies his grease gun at "C," he knows when fresh grease appears at "E" that he has cleared the passage of all dirt and old grease and completely filled it with fresh lubricant for there are NO DEAD ENDS OR AIR POCKETS. The port "E" also serves another purpose. It relieves the grease channel from the built-up pressure from the grease gun, hence the grease is not forced out between the disc hub and shaft on the face of the disc and upon the belt.

The question of proper lubrication of a variable speed transmission is of paramount importance. The patented Lewellen Lubrication System for disc hubs, keys and shafts is simple, positive and highly efficient. There are no oil pipes, hose or tubes to become loose or to interfere with the accessibility of the working parts of the transmission. The entire transmission may be lubricated without removing the cover of the enclosed type or without stopping operation. With a minimum amount of attention sticking or "freezing" is impossible, thus eliminating expensive repairs and replacements.

In addition there are other exclusive Lewellen features that ***mean years of trouble-free service.*** The famous ***double-block belt*** and ***unbreakable belt splice;*** a ***flexible bearing suspension*** that is self-aligning in every direction; the mounting of ***thrust bearings*** at the outer end of the disc hub. The bearing housing is bolted to the disc hub. When the lever moves outwardly, it moves the disc positively and does not require the belt to force discs apart.



Call a Lewellen Representative or Write Us NOW!

LEWELLEN MFG. CO., Columbus, Ind.

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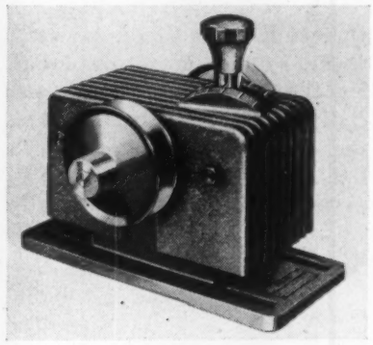
LEWELLEN *Variable Speed* **TRANSMISSIONS**

NEW Materials and Parts

Variable Speed Unit Announced

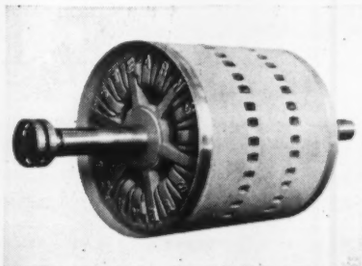
GIVING a speed variation over a 5 to 1 ratio and utilizing only standard V-belts to transmit power, the "Select-O-Speed" transmission is announced by Ideal Commutator Dresser Co., 1059 Park avenue, Sycamore, Ill. Compact and flexible design makes it easy to build this new transmission into the original design or new equipment. Several sizes are available up to 7½ horsepower. Variation of the speed ratio is made possible by an ingenious yet simple arrangement of two interlocking sheaves which may be pivoted laterally by a slight movement of a control lever, thus changing the driving and driven belt tensions. This change automatically causes the sheaves to adjust themselves to a new pitch diameter for the new speed ratio. The unit will operate in any position.



V-belts are used for the drive between the two sheaves, the pitch diameters of which are changed to give speed variation

Magnetic Pulley Is Improved

IMPROVEMENTS in the Stearns high duty magnetic pulley to enhance the efficiency of its line of magnetic separators have been announced by Stearns Magnetic Mfg. Co., Milwaukee. To allow for greater radiation area a new ribbed construction has been designed, including deeper coil pockets for more copper

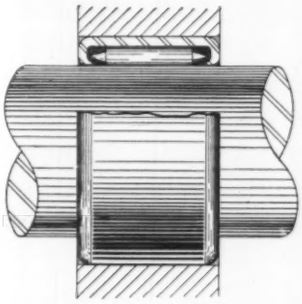


Air is forced around electrical coils of magnetic pulley to insure adequate cooling

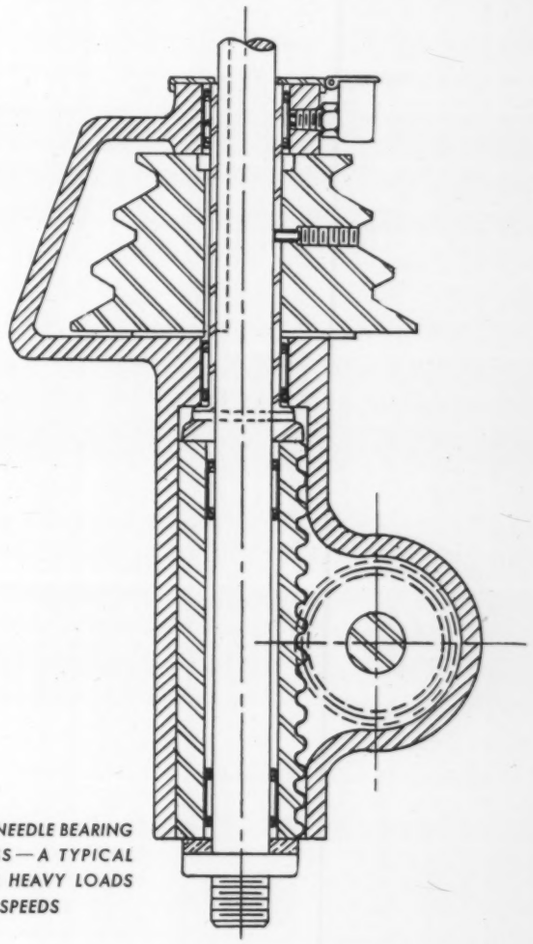
TORRINGTON NEEDLE BEARING

DESIGN AND SERVICE FEATURES

BEARING TAKES HEAVY LOADS AT HIGH SPEEDS



Small Sizes Have High Capacity



THE TORRINGTON NEEDLE BEARING IN A DRILL PRESS—A TYPICAL APPLICATION FOR HEAVY LOADS AT HIGH SPEEDS

RADIAL LOAD capacity of the new Torrington Needle Bearing is an important advantage in high speed rotary applications such as the drill press illustrated. This application is typical of conditions where capacity for sudden heavy loads must be provided in a small space. The Needle Bearing, with its full complement of small diameter needles, is ideal for such applications.

Ease of lubrication of the Needle Bearing reduces the need of maintenance attention and keeps the bearing from becoming overheated. The turned-in lips of the hardened retaining shell provide a reservoir which holds an ample supply of lubricant for long periods of operation.

Simple Housing Design

The construction of the bearing—long axially and small in diameter—permits the use of the simplest type of housing design, with resulting economies in space and cost. The advantages of anti-friction construction can be utilized in a space comparable with that required by a simple bushing. Additional economies in production result from the bearing's low unit cost and the ease with which it is assembled in the housing.

Manufacturers interested in investigating the use of this unusual bearing in their products are invited to avail themselves of the experience of the Torrington Engineering Department in laying out bearing applications. Further information is given in the Torrington Needle Bearing Catalog, available on request. Write for Catalog No. 9.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Ball and Needle Bearings
Branch Offices in all Principal Cities

TORRINGTON
NEEDLE BEARING

OHIO GEARS —'way up in Tramrail Performance

● Wherever Cleveland Tramrail hurries its loads high overhead, you'll find Ohio Gears. For Ohio Gears play an important part in the smooth, dependable performance of these sturdy carriers.

Smooth operation under shock and strain, precision of cut, proved durability, resistance to wear and quick, reliable service were some of the characteristics sought by the Cleveland Tramrail engineers for the gears to be used in this unit. And their choice was Ohio Gears. Cleveland Crane & Engineering Co. is but one of the important companies specifying Ohio Gears as standard on their machines and equipment.

Does the dependable operation of your product rely on precision cut, sturdy gears? If so, check Ohio Gears for your needs. For design or maintenance their advantages are well worth your consideration. Write today.

THE OHIO GEAR CO.
1338 E. 179th Street · Cleveland, Ohio

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*San Francisco, Calif. Adam-Hill Co., 244-246 Ninth Street.
Indianapolis, Ind. A. R. Young, 518 North Delaware Street.
Louisville, Ky. Alfred Halliday, 330 Starks Building.
Detroit, Mich. George P. Coulter, 322 Curtiss Building.
Minneapolis, Minn. W. H. Erskine, Box 72, Traffic Station.
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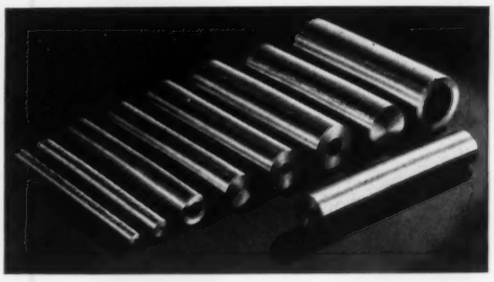
New York City, N. Y. E. G. Long Co., 50 Church Street.
Grand Rapids, Mich. W. H. Slaughter, 419 Oakdale St., S. E.
New England. George G. Pragst, 260 Esten Ave., Pawtucket, R. I.
Pittsburgh, Pa. Industrial Sales & Engineering Co., Box 8606, Wilkinsburg, Pa.
Salt Lake City, Utah. A. O. Gates, 619-629 South Fifth West Street.
*Stocks carried.

OHIO GEARS

wire and more ampere turns with subsequent greater magnetic strength. Coil windings have increased efficiency due to greater cooling area furnished by the forced air circulation, caused by the compressive action of the belt which forces the cooled air into the ribbed interior of the pulley on the upper side and expels the heated air by the suction of the belt on the lower side. Windings are completely surrounded by steel, thus being fully protected against any external hazards. Another feature of the magnetic pulley is its weatherproof construction. Special gland type fittings seal the lead-in wires against moisture. Voids under the coil covers are filled with high temperature melting compound.

Alloy Bronze Bars for Bearings

LINE of cored and solid bronze bars for bearing materials, to be known as "Bunting Precision Bronze Bars", is announced by The Bunting Brass & Bronze Co., Toledo. The material used in the bars



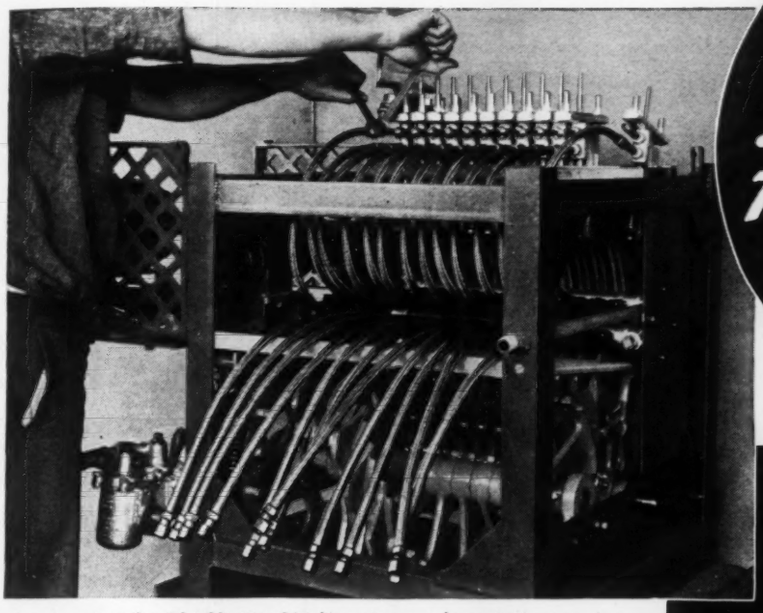
Bronze bars are made by new casting technique which insures uniform quality throughout the material

was developed to provide an alloy that would have ample strength to resist heavy loads and perform satisfactorily under various adverse operating conditions. To give satisfactory antifriction qualities as well as long life and a minimum amount of wear, the alloy was worked out after many months of laboratory work and is composed of 83 per cent copper, 7 per cent tin, 7 per cent lead and 3 per cent zinc. The bars are made by a new casting technique which produces a metallic structure of unvarying uniformity regardless of the diameter or wall thickness. Over 240 sizes of these fully machined cored and solid bronze bars are now carried in stock.

Controllers Have Unique Timing Device

LINE of direct current controllers for heavy duty machine tool applications below 10 horsepower and for general purpose above 10 horsepower are announced by Cutler-Hammer Inc., 328 North 12th street, Milwaukee. Unique timing device which operates magnetically on the principle of a condenser discharging through a magnet coil provides simple, positive, precise and definite time acceleration which

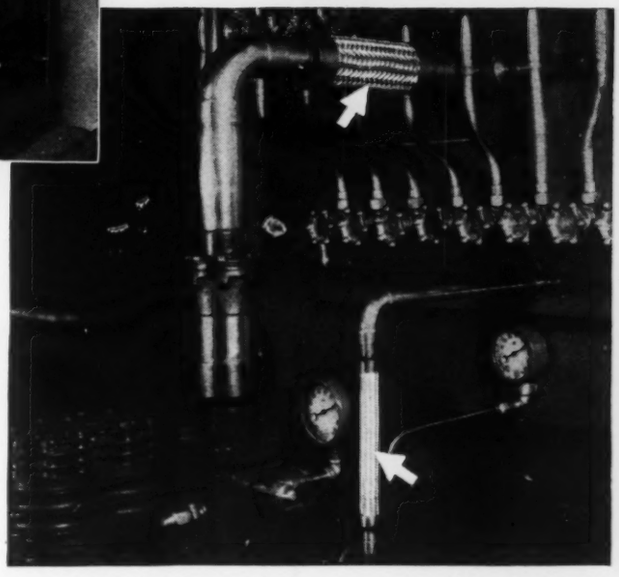
American Flexible Hose means Permanent Service



American Seamless Flexible Metal Tubing gives steady service in conveying steam to hosiery molds while flexing back and forth continuously.

AGAINST the twin menaces of vibration and seepage, American Metal Hose and Tubing offers industry a potent weapon. Wherever a flexible connector or conductor is needed to take up movement of parts, or where vibration threatens to crack rigid pipe, "American" has a seamless, all-metal flexible tubing to fill the bill. For carrying air, oil, water, steam, or fuels of various kinds, "American" has 30 years of successful experience to recommend it. Past tests have proven that it is the hose for present *and future* service.

Illustrated are but 2 of the countless applications of this sturdy, seep-proof tubing. The machine tool builder, the air conditioning manufacturer, the locomotive designer, the air craft maker — these and many other vital industries fully realize the value of properly designed, leakproof connectors as original parts on their products. In maintenance work, too, American Metal Hose scores heavily, preventing shut downs and cutting costs. 38312



American Flexible Vibration Eliminators are used to form a break in the refrigerant lines on air conditioning and refrigerating machinery, or in any rigid pipe line that is subject to the devastating effect of vibration.

• • •

ANACONDA
from mine to consumer

Write us in detail about your problem. Our Engineering Service will extend the fullest cooperation without cost.

THE AMERICAN BRASS COMPANY

American Metal Hose Branch

General Offices: WATERBURY, CONNECTICUT

"saved its cost during the first year"

So writes the president of a mid-western rubber company. He continues:

"We find that Ozalid Prints are easier to read and our workmen like them better than blue prints. We have often commented among ourselves about the improvement in 'our process.' In fact, we would not know what to do without it."

There you have the executive viewpoint . . . with emphasis, naturally upon the savings effected by the Ozalid Process. Now let's see what an engineer has to say about it:

"vastly superior to blue printing"

"We have found the Ozalid Method vastly superior to blue printing and other wet processes, not only because of the clear, legible, accurate-to-scale prints, but also because of the ease and speed of making such prints. There is no delay in washing and drying or in the mixing of chemicals, and long or short runs are handled efficiently.
"Ozalid White Prints are much easier to read, showing marks and corrections at a glance. Also, changes and additions to the prints can be made in ink, making them as legible as the original printed lines."

Finally, here are typical comments from the draftsman's viewpoint. They are from the chief draftsman of a leading laundry machinery company:

"many short-cuts in drafting time"

"We particularly like the cleanliness and speed of the Ozalid Unit, as it eliminates the washing and drying of prints, which has always been a sloppy operation.
"We have found that Ozalid transparent tracing cloth offers many short-cuts in drafting time. We simply make a master ink tracing of certain parts, omitting the variable dimensions, the latter being filled in on Ozalid tracing cloth prints which are made from the original tracing."

These remarks on the Ozalid Process were picked at random from more than a hundred enthusiastic letters received recently from Ozalid users. You, too, will be enthusiastic about this revolutionary method of print making, when you discover all the advantages that the Ozalid Process offers.

The coupon below will bring you complete information

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OZALID CORPORATION,
354 Fourth Avenue, New York

Please send printed matter about the Ozalid Process, together with prices and samples of Ozalid White Prints.

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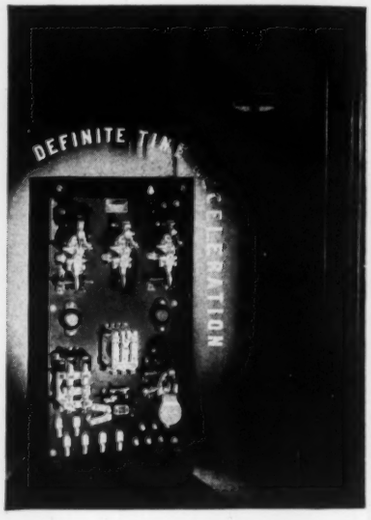
City ..... State .....

MD-8-38

is unaffected by load, temperature or other working conditions. Once adjusted to obtain the desired starting period, the controller will always accelerate in this same time. Other construction features include: Styled case; snap-on type cover which can be completely removed for installation and wiring; tilting panel frame which allows quick access to the rear of

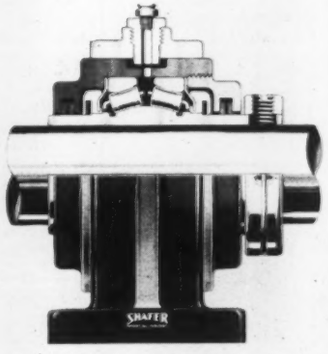


Controllers will handle heavy duty loads for motors under 10 horsepower and will carry ordinary loads for motors up to 75 horsepower. They may be used with either pushbutton or drum-type master switches

panel at all times; wiring trough in the rear compartment; and heavy duty contactors. Controllers are available in reversing and non-reversing types, with and without dynamic braking, for both constant speed and adjustable speed motors. They may be used with either pushbutton or drum type master switch and are supplied in all NEMA ratings up to 75 horsepower, 115 volts; and 150 horsepower, 230 and 550 volts.

Pillow Block Housings Are Welded

EMBODYING welded steel housing construction, super-sealed pillow blocks have been placed on the market by Shafer Bearing Corp., 35 East Wacker



Three sealing mediums are used to prevent the entrance of dirt or the escape of lubricant from bearing

Drive, Chicago. Electrically welded steel construction provides a rugged housing of compact dimensions with

REDUCTORS* is the registered trade name for Boston Gear Speed Reducers, and there are more than 5000 of them in stock ready for your use. This stock comprises 278 different ratios, types and sizes. On a moment's notice you can get a Reductor in almost any ratio between 3 to 1 and 4000 to 1. Forty pages of our New General Catalog No. 52 are devoted to specifications and list prices of these Reductors. You will also find in this catalog simple engineering formulas which will help you with your own selection. Boston Gear Reductors are carried in stock by the following authorized distributors who will be glad to give you a copy of our General Catalog No. 52 and serve you whenever the occasion arises:

AKRON, OHIO
Manufacturers Rubber & Supply Co.

ALBANY, NEW YORK
Sager-Spuck Supply Co., Inc.

ALLENTOWN, PENNSYLVANIA
Wm. H. Taylor & Co., Inc.

ATLANTA, GEORGIA
J. M. Tull Metal & Supply Co.

BALTIMORE, MARYLAND
Carey Machinery & Supply Co.

BINGHAMTON, NEW YORK
Ellis W. Morse Company

BOSTON, MASSACHUSETTS
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BRONX, NEW YORK, N. Y.
Bronx Hardware & Supply Co.

BROOKLYN, NEW YORK
H. L. Dickie

BUFFALO, NEW YORK
Root, Neal & Company

CANTON, OHIO
Manufacturers Rubber & Supply Co.

CHARLESTON, WEST VIRGINIA
Baldwin Supply Company

CHARLOTTE, NORTH CAROLINA
Mathews-Morse Sales Company

CHATTANOOGA, TENNESSEE
Chattanooga Belting & Sup. Co.

CHICAGO, ILLINOIS
Boston Gear Works, Inc.
H. Channon Company
Chicago Pulley & Shafting Co.

CINCINNATI, OHIO
The Queen City Supply Co.

CLEVELAND, OHIO
Boston Gear Works, Inc.
The Mau-Sherwood Supply Co.

DALLAS, TEXAS
George J. Fix Company

DAYTON, OHIO
Klinger-Dills Company

DENVER, COLORADO
Denver Equipment Company
Western Belting & Packing Co.

DES MOINES, IOWA
Standard Bearings Co.

DETROIT, MICHIGAN
The Chas. A. Strelinger Co.

HARTFORD, CONNECTICUT
Silliter-Holden, Inc.

INDIANAPOLIS, INDIANA
Vonnegut Hardware Company

KANSAS CITY, MISSOURI
Ellfeldt Hdwe. & Machine Sup. Co.

KNOXVILLE, TENNESSEE
W. J. Savage Co., Inc.

LOS ANGELES, CALIFORNIA
Andrews Hardware & Metal Co.

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Industrial Equipment Co.

MEMPHIS, TENNESSEE
Lewis Supply Co.

MIAMI, FLORIDA
W. N. Herod & Company

MILWAUKEE, WISCONSIN
The Western Iron Stores Co.

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MONTREAL, QUE., CANADA
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R. J. Tr con Company

NEW YORK CITY
L. C. Big'ow & Co., Inc.
Boston Gear Works, Inc.

NORFOLK, VIRGINIA
R. W. Hudgins & Sons

OAKLAND, CALIFORNIA
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PEORIA, ILLINOIS
Couch & Heyle, Inc.

PHILADELPHIA, PENNSYLVANIA
Boston Gear Works, Inc.
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PITTSBURGH, PENNSYLVANIA
Somers, Fitler & Todd Co.

PORTLAND, OREGON
Woodbury & Company

PROVIDENCE, RHODE ISLAND
Machine Parts Corporat.on

RICHMOND, VIRGINIA
Apex Machine Manufacturing Co.

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M. J. Torrance Elec. Supplies

ST. LOUIS, MISSOURI
Colcord-Wright Mach. & Sup. Co.

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Alamo Iron Works

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SAVANNAH, GEORGIA
John D. Robinson Co.

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Chas. B. Scott Co.

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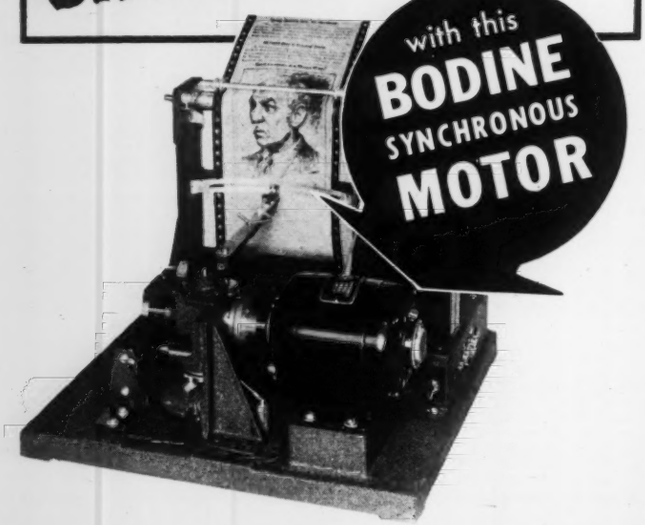
* Reductors Reg. U. S. Patent Office

BOSTON GEAR WORKS, INC. NORTH QUINCY, MASS.

Finch Facsimile gets

SMOOTH, QUIET POWER
UNVARYING SPEED

with this
BODINE
SYNCHRONOUS
MOTOR



● Finch Facsimile is a method of transmitting photos and printed matter by radio. But for faithful transmission, the Finch transmitter and receiver have to be driven by motors that are free from all vibration. The angular velocity of these motors has to be absolutely constant. Quietness is important, too. Bodine engineers cooperated with Finch and selected a standard 1/75 hp Bodine synchronous motor that met all requirements.

Your machine, too, may require a motor with special speeds and torques or a motor that gives extra quietness and reliability. Whatever your needs, Bodine has a standard motor for the job. For more than 34 years Bodine engineers have specialized in engineering motors from 1/2000 to 1/6 hp, to meet individual requirements. They can help solve your motor problems. Write Bodine Electric Co., 2258 W. Ohio St., Chicago.

What is a Synchronous Motor?

A synchronous motor is one whose speed is determined by the frequency of the a-c supply. Consequently, synchronous motors maintain a constant speed regardless of load. They start as induction motors and then "pull into step" with the a-c pulsations. Synchronous motors are used on clocks, timers, and wherever unvarying speed is required.

BODINE

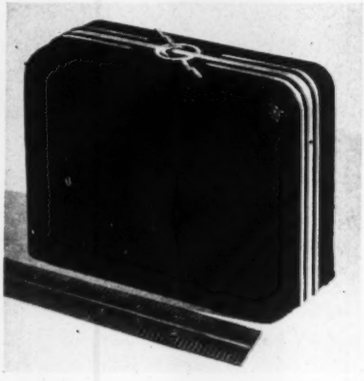
FRACTIONAL H. P.
MOTORS

ENGINEERED FOR YOUR PRODUCT

bearings of ample capacity for severe applications. The double row self-aligning roller bearing is mounted in a cartridge housing containing the sealing members, three of which are used. An outer felt is free to float in the cover groove, and is always in uniform contact with the inner race of the bearing under any conditions of misalignment. Inner seal plates are mounted between covers and bearing; washers are pressed on the inner race, and together with the inner seal plates form modified labyrinth seals. Pillow blocks are available in shaft sizes from 1 7/16 to 3 15/16 inches.

Photoelectric Cell Control Device

UNUSUALLY small and compact light beam control unit has been introduced by Electronic Control Corp., 2667 East Grand Blvd., Detroit. Units are housed in cast aluminum containers, contributing to easy mounting of the device. The light relay, type 257, is complete in aluminum housing 7¼ inches long, 5½ inches high and 3½ inches wide, finished in

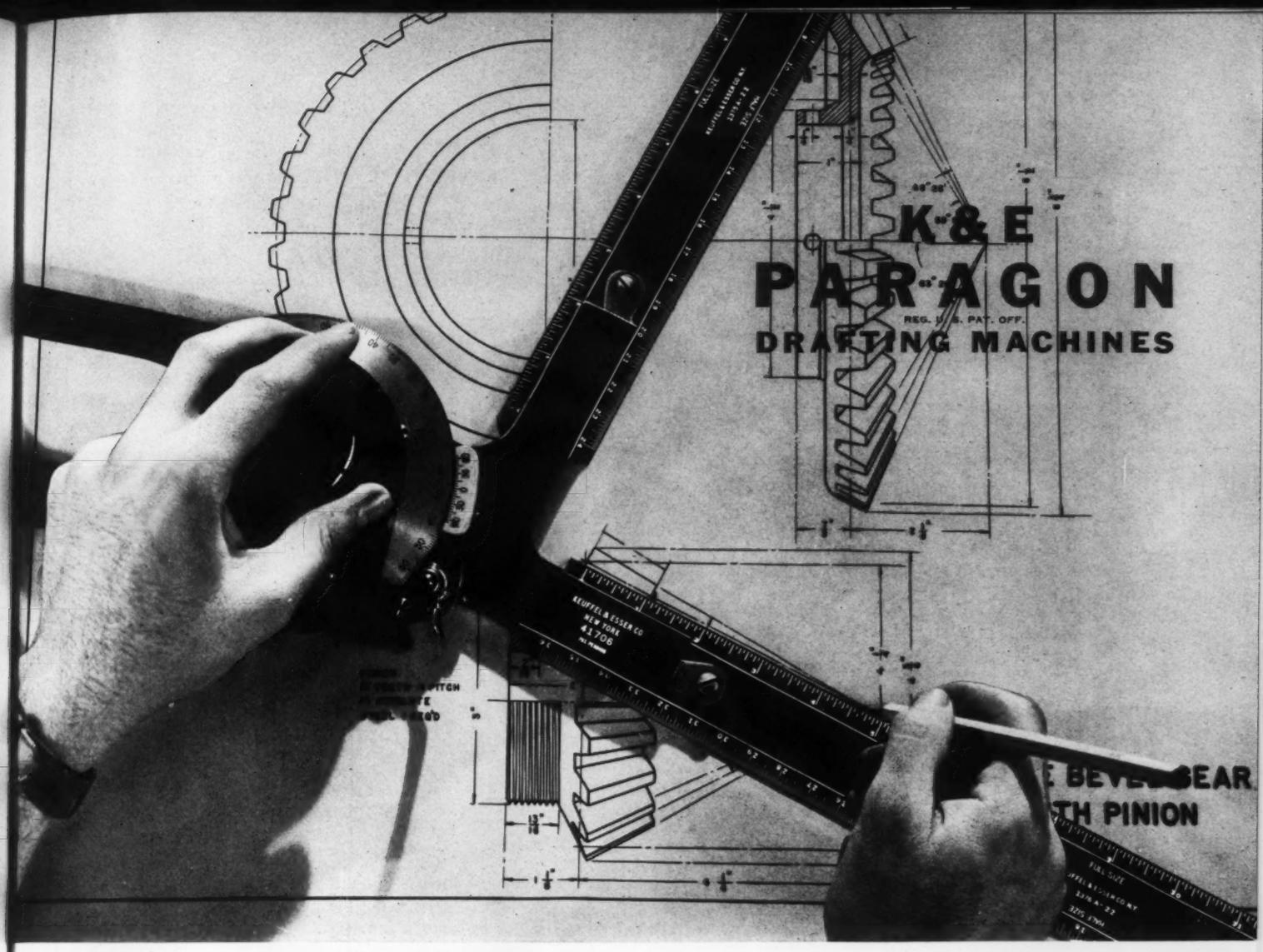


Light beam control device is housed in neat appearing aluminum container. It is less than seven inches long

black optical instrument enamel with a readily removable chassis upon which are mounted an amplifying tube and photoelectric cell. Contact capacity of magnetic switch in unit will handle ¼ horsepower motor. Expected life of photoelectric cell is from 20,000 to 30,000 hours, with the radio amplifying tube from 1000 to 2000 hours. Device operates directly on 115-volt, 50 or 60-cycle alternating current and consumes less than 50 watts.

Neoprene Rubber Used in New Hose

TO PROVIDE resistance to the action of oil, a new type of fuel and oil line utilizing a flexible metal core protected by "Cellophane" cellulose film and neoprene chloroprene rubber is being manufactured under the tradename "Avioflex" by The Chicago Metal Hose Corp., Maywood, Ill. Though perfected primarily for use in aircraft, the hose is now being introduced into industrial applications. The specially prepared laminated cellulose sheeting provides a seal over the entire inner tube, being imper-



SPEED UP YOUR DRAFTING TECHNIQUE!

This improved drafting machine will increase your drawing efficiency by 25 to 50 percent. The functions of T-square or straightedge, triangles, protractor and scales are all combined in one convenient unit —*controlled entirely by the left hand.* A feather touch moves the scales into position, giving you a horizontal *and* a vertical at any point on the board. A motion of the thumb lock produces any angle you require. All lines are drawn to exact length, along the scales, with no "ends" to erase later. No need to retrace, or duplicate efforts.

You will do better work with this advanced technique, and at a speed impossible by conventional drafting methods. Hundreds of detail motions are eliminated, permitting you to concentrate on the actual design. Your right hand is always free to draw, your undivided energies go into the problem on the board, and your drawing builds steadily, without distraction or interruption.

You will want to know more about the Paragon drafting machine. Ask your K & E dealer to arrange a demonstration, or write for a copy of the new booklet.

EST. 1867

KEUFFEL & ESSER CO.

NEW YORK · HOBOKEN, N. J.

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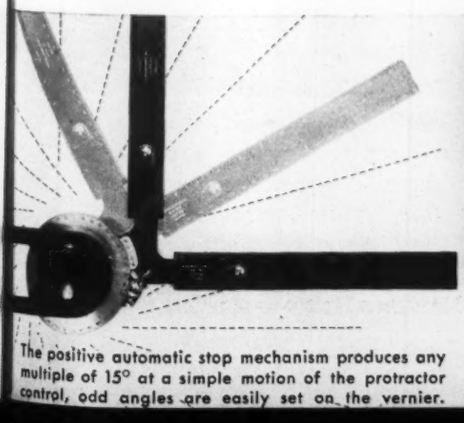
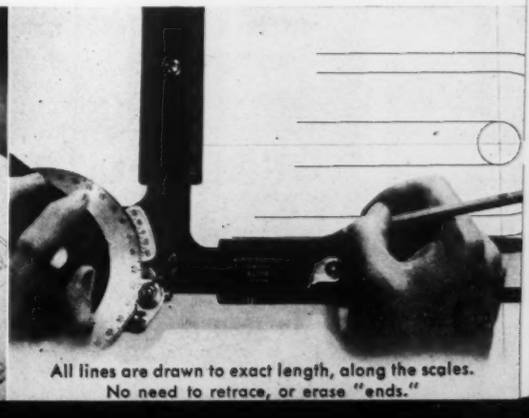


The positive automatic stop mechanism produces any multiple of 15° at a simple motion of the protractor control, odd angles are easily set on the vernier.



All lines are drawn to exact length, along the scales. No need to retrace, or erase "ends."

FLAMENOL WIRE

IS EASY TO STRIP

WITH a sharp knife, or wire-stripper, you can easily remove the single covering of Flamenol on this wire—and make connections in a jiffy. You thus save time.

You save, too, in other ways. Space, for example. Flamenol has such high dielectric and mechanical strength that a single covering serves both as insulation and finish; and the wire, for say 600 volts, is smaller in diameter than any other insulated wire.

These and other unique properties—nine colors, resistance to flame, water, oil, acids, and age—make Flamenol ideally suited for low-voltage wiring on such high-grade equipment as machine tools. You'll find that it will solve difficult wiring problems on your product. A G-E cable specialist will gladly help. Address nearest G-E sales office or General Electric Company, Department 6—201, Schenectady, N. Y.

INSULATED WIRE ALWAYS THE RIGHT TYPE FOR EACH JOB

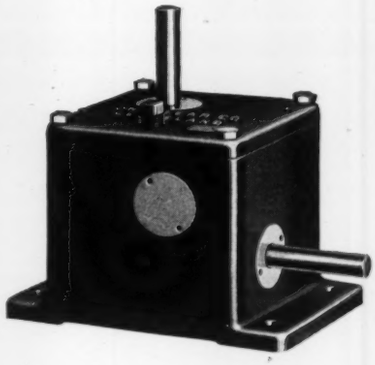
GENERAL ELECTRIC

520-150

vious to oils and all hydrocarbon fluids under normal and high temperatures. A vulcanized neoprene cover binds the unit together, providing double protection. Metal braid forms the outer shell.

Small Reducer Has Large Speed Ratio

NEWEST addition to the line of speed reducers made by Ohio Gear Co., Cleveland, is a small vertical double speed reducer, having outside dimensions of 4½ x 4½ x 4½ inches. Input and output shafts are at right angles in either the horizontal or vertical plane. Special advantage lies in the fact that

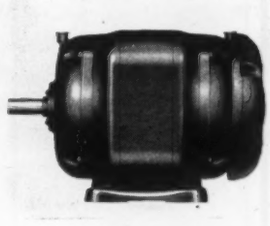


Input and output shafts are at right angles to each other, allowing variety of locations of shafts without changing position of gear box

a variety of locations for the input and output shaft is possible without changing the mounted position of the gear box. Either ball or roller bearings are available. Torque capacity is 100 inch pounds in the reducers having speed ratios from 100 to 800 : 1, and 25 inch pounds in one model with 1600 to 1 ratio. The new reducer, known as V00, is carried as a standard stock.

Glass Used for Motor Insulation

LIGHTER and more compact motors are possible by the use of glass insulation, employed in the new streamcooled motors of Baldor Electric Co., 4400



More efficient motor operation is possible as high temperatures may be withstood due to glass insulation of coils

Duncan avenue, St. Louis. Regular polyphase motors are constructed of steel, copper and insulating material. Important factor on the size, weight and cost of a motor is the temperature limitations of the insulating material. Until recently, cellulose mate-

Vertical gear-motor for flange mounting
Explosion-proof gear-motor of induction design
Splashproof gear-motor of induction design
Totally enclosed, fan-cooled gear-motor
Totally enclosed, ventilated gear-motor, arranged for ceiling mounting
Fractional-hp concentric-shaft gear-motor
Single-reduction integral-hp gear-motor of open squirrel-cage design
Right-angle-shaft fractional-hp gear-motor
Totally enclosed, fan-cooled, vertical gear-motor with forced-feed gear lubrication
Squirrel-cage induction gear-motor with feet on cover-plate
Splashproof gear-motor with a gear unit at each end

Which Type of G-E Gear-motor Do You Need for Your Low-speed Drive?

No matter what type of low-speed drive you may need for your conveyors, mixers, agitators, pumps, or other low-speed machines, a gear-motor is the correct solution.

G-E gear-motors are available in ratings from 1/8 to 75 hp, with output-shaft speeds from 6 to 600 rpm, in polyphase, single-phase, or direct-current types—a type to fill every requirement.

The coupon to the right will bring you two booklets that will describe and explain G-E gear-motors and their applications. General Electric, Schenectady, N. Y.

General Electric Company
Dept. 6F-201, Schenectady, N. Y.

Please send me a copy of each of your two new bulletins, GEA-1437C and GEA-1919A, that will give me complete and detailed information about G-E gear-motors.

Name_____

Company_____

Address_____

City_____ State_____ 020-373

GENERAL ELECTRIC

020-373

Dodge Bearings Reflect Credit on Your Design

THOUSANDS of standard and special Dodge Rolling Bearing Units provide the machine designer with an unlimited scope. All represent the sound design and quality manufacture that have made Dodge the world's largest maker of Power Transmission Equipment. "*Staying Power*" — Outstanding Stamina — those are qualities in Dodge Bearings which reflect credit on the machine designer's selection. There's more than half a century of dependability behind the Dodge name.

Send for copy of Dodge "Rolling-Bearings" Catalog

THE Right Drive FOR EVERY JOB

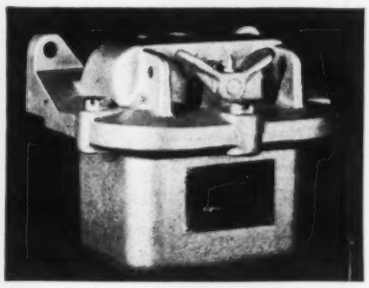
DODGE MANUFACTURING CORPORATION
MISHAWAKA, INDIANA, U.S.A.

DODGE
MISHAWAKA
THERE IS ADDED VALUE IN THE NAME DODGE

rials were most generally used, but they deteriorate rapidly at 100 degrees Centigrade. Recently glass, which is excellent insulation, has been spun as fine as silk and as flexible as cotton. Use of this glass in the new motors makes possible highly efficient and very compact motors having more horsepower output per pound of active iron and copper. These new motors are available in three phase, 220/440 volt, 60 cycle, 4 pole, rated at 1725 RPM.

Pushbutton Stations Resist Corrosion

LINE of heavy duty Type HD pushbutton stations, suitable for use in corrosive atmospheres and in hazardous locations, has been designed by Westinghouse Electric & Mfg. Co., East Pittsburgh. These

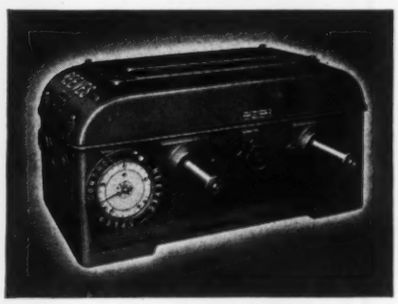


High-grade cast iron is used for station housing and bolts and working parts are of copper alloy

stations are designed in accordance with the requirements of the Underwriters' Laboratories and are explosionproof either with or without oil in the station. They are available with from one to four standard pushbuttons of the momentary type or with maintained contact units. High-grade cast iron is used for the stations and all bolts, shafts and fittings are of corrosion-resisting copper alloy.

Speed Indicator for Transmissions

NEW type of speed indicator, for use with Reeves variable speed control equipment, is announced by Reeves Pulley Co., Columbus, Ind. Known as the



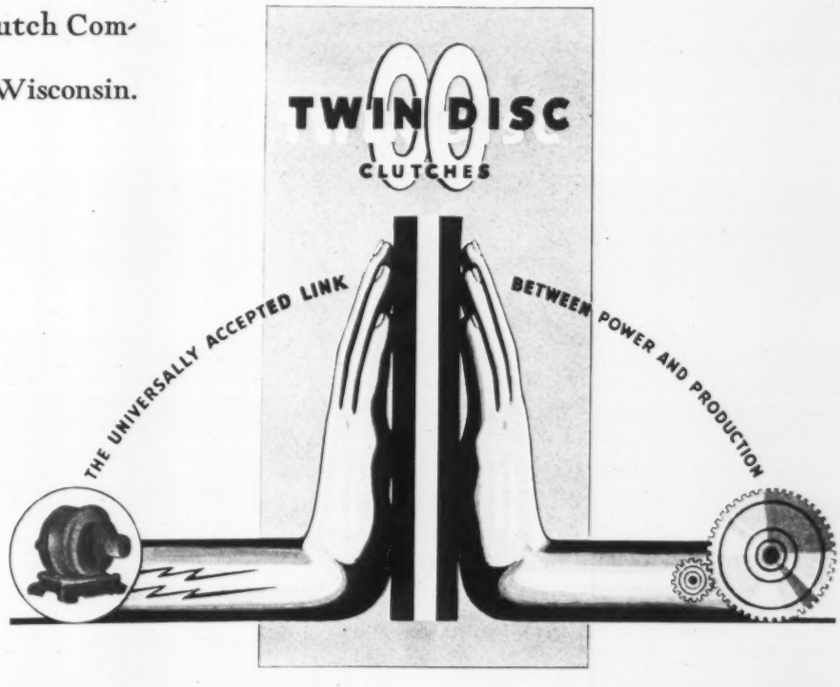
Space is provided on dial of speed indicator to write in pen or pencil the calibrations of user for certain speeds

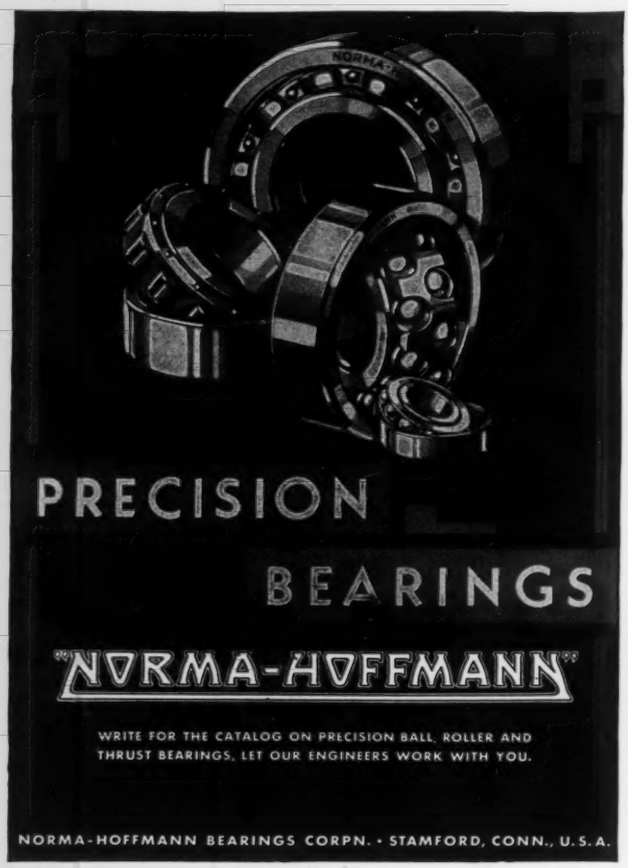
"Speedial" handwheel, it accurately registers speed settings of the different variable speed units made by the company, and may be used in place of the regular

at 21 we feel rich

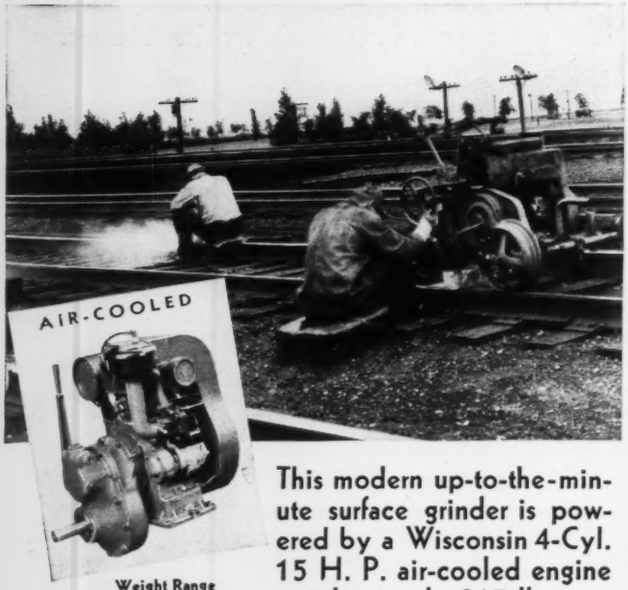
Rich in the friendship of America's leading industries. *Rich* in the loyal patronage of so many manufacturers who continue, through the years, to standardize on Twin Disc Clutches. *Rich* in the confidence of engineers, so amply demonstrated in a recent national survey in which they voted a 5 to 2 preference for Twin Disc Clutches. ℘ Such riches constitute real wealth . . . "unlisted securities" . . . tax-free, but invaluable. And, because all wealth means added responsibility . . . at twenty-one we pledge a continuance of the close cooperation, the whole-hearted interest in your problems, the zealous guarding of those high standards which won your patronage and made it such a valued asset.

Twin Disc Clutch Company, Racine, Wisconsin.




PRECISION
BEARINGS
"NORMA-HOFFMANN"
WRITE FOR THE CATALOG ON PRECISION BALL, ROLLER AND THRUST BEARINGS, LET OUR ENGINEERS WORK WITH YOU.
NORMA-HOFFMANN BEARINGS CORPN. • STAMFORD, CONN., U.S.A.

"SPECIALIZED EQUIPMENT NEEDS SPECIALIZED POWER"



Weight Range
60 lbs. to 340 lbs.
Power Range
1 to 30 H. P.

This modern up-to-the-minute surface grinder is powered by a Wisconsin 4-Cyl. 15 H. P. air-cooled engine weighing only 215 lbs.

★ FURTHER DETAILS ON REQUEST

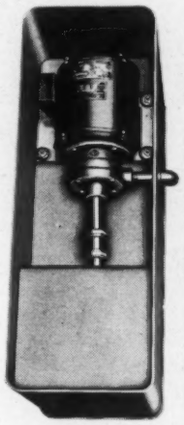
HEAVY DUTY AIR COOLED ENGINES by WISCONSIN MOTOR CORPORATION

WISCONSIN
MOTOR CORP., MILWAUKEE, WIS.

handwheel. Actual indication is a definite number of turns (and fractions of turns) of the shifting screw. These are read by the operator as he turns the Speedial. Space is available on the dial for the user to write his own calibrations in whatever corresponding units he prefers.

Coolant Tank, Pump in One Unit

SERIES of self-contained coolant tank and pump units designed to serve as a complete individual or standby unit for supplying coolant to one or more machines has been brought out by Pioneer Engineering & Manufacturing Co. Inc., 31 Melbourne avenue, Detroit. Tanks are of welded steel throughout and

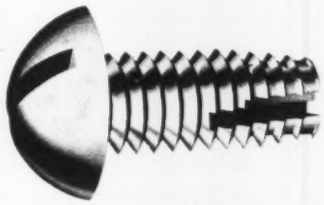


All welded tanks are used in this combined coolant tank and pump unit. Pumps are available in sizes from 1 to 80 gallons per minute

are fitted with a cast-iron cover. Pumps available with the different tank models provide capacities from 1 to 80 gallons per minute and pressures up to 23 pounds per square inch. Units also have chip baskets and filter bags as optional equipment. Five different sizes are available.

Thread Cutting Screw for Plastics

EXPRESSLY manufactured for plastic materials, The Shakeproof Lock Washer Co., 2501 North Keeler avenue, Chicago, has developed the "hi-hook" thread cutting screw to supplement its line of thread



Slot in screw gives sharp edge that cuts clean thread in all plastic materials

cutting screws for other materials. Specially designed double-width slot gives an acute edge that cuts a clean, sharp thread in all types of plastic composi-

Crank Gear for Shaper 24" diam.
Coffee-Mill Burr—4"
Worm Box for Hydraulic Attachment, 15" max. dimension
High-Pressure Pump actuates hydraulic plungers on Shearing Machine. Max. Section 1½". Min. ¾".
for difficult CASTINGS
depend on
Valve Liner for Steam Engine 11½" O. D.
Blank Gear for Lens Grinder
METAL MEEHANITE

From the big gear for grinding the reflector of a 200-inch telescope, the largest in the world, to the intricate precision-made part of the most delicate small mechanism—many are the uses to which the highly adaptable casting metal, MEEHANITE, brings advantage. Extraordinary strength and toughness, close grain, great uniformity, resistance to wear and corrosion are among its merits—at relatively low cost. Ask for specification data.

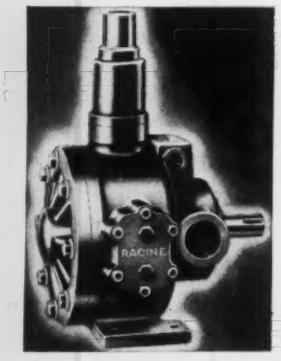
ON ANY EXACTING USE . . . . . CONSULT THESE LICENSED MANUFACTURERS

Heavy Gears . . . Fly Wheels . . . Hoppers . . . Ore Buckets . . . Camshafts . . . Crankshafts . . . Sprockets . . . Metal Forming Dies . . . Small Gears . . . Precision Parts of engines, compressors, printing presses, calculating machines, etc., etc.

American Laundry Machinery Co.	Rochester, N. Y.
Atlas Foundry Co.	Detroit, Mich.
Banner Iron Works	St. Louis, Mo.
Barnett Foundry & Machine Co.	Irvington, N. J.
H. W. Butterworth & Sons Co.	Bethayres, Pa.
Cincinnati Grinders Incorporated	Cincinnati, Ohio
The Cincinnati Milling Machine Co.	Cincinnati, Ohio
Cooper-Bessemer Corporation	Mt. Vernon, Ohio
M. H. Detrick Co.	Peoria, Ill., Newark, N. J.
Farrel Birmingham Co.	Ansonia, Conn.
Florence Pipe Foundry & Machine Co. (R. D. Wood Company, Philadelphia, Selling Agents)	
Fulton Foundry & Machine Co.	Cleveland, Ohio
Gwenlee Foundry Company	Chicago, Ill.
Hamilton Foundry & Machine Co.	Hamilton, Ohio
Kanawha Manufacturing Co.	Charleston, West Va.
Kinney Iron Works	Los Angeles, Calif.
Kohring Company	Milwaukee, Wis.
E. Long, Ltd.	Orillia, Canada
Pondale Foundry & Machine Co.	Pittsburgh, Pa.
Rice-Meehan Foundries	Chattanooga, Tenn.
The Stearns-Roger Mfg. Co.	Denver, Colo.
Vulcan Foundry Company	Oakland, Calif.
Warren Foundry & Pipe Corp.	Phillipsburg, N. J.
Washington Iron Works	Seattle, Washington
Australian Meehanite Metal Co., Ltd.	Waterloo, N. S. W.
The International Meehanite Metal Co., Ltd.	London
Meehanite Metal Corporation	Pittsburgh, Pa.

RACINE

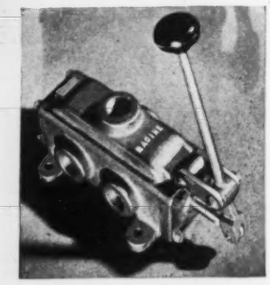
Variable Volume Hydraulic Pumps



Extremely quiet, smooth performance. A thoroughly proven, efficient pump for pressures up to 1000 lbs. per sq. inch. Capacities 2000—4000—6000 cubic inches per minute.

The Variable Volume feature saves horse-power. Delivers amount of oil actually required. Volume is controlled automatically or manually.

Write for new catalog P-10

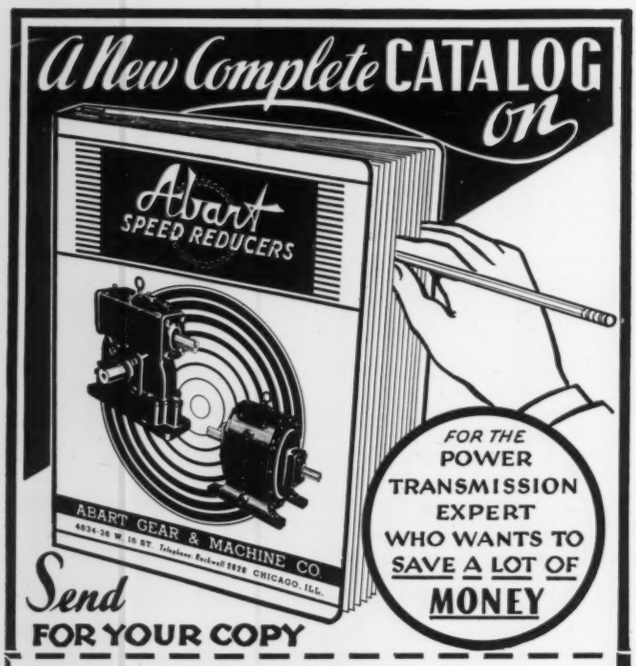


Racine Hydraulic Valves

A complete line—manual—pilot or electrically operated. Balanced pistons—Accurately fitted.
For oil-hydraulic installations.

Write for new catalog V-10

RACINE TOOL & MACHINE CO.
1773 State St. Racine, Wis.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tions, both molded and laminated. Because the screw cuts a standard thread, it may be replaced if necessary by a conventional screw of the same size without damaging the tapped hole. The need of a separate tapping operation or threaded inserts is also eliminated, the only requirement being that the screw be inserted in a molded or drilled hole of the proper size and driven home.

Dual Magnetic Valve for Flow Control

DUAL magnetic valve for high-low fire or high-low flow control has been announced by General Controls Co., 450 East Ohio street, Chicago. It has two electrically independent solenoids operating two lever-action, high-pressure valves. Lever action develops six times the opening and closing power. Thus, the "General Dual K-10" will handle oils as heavy as No. 6 at usual room temperatures and steam up to 125 pounds per square inch pressure. Flow adjustments are provided on both ports. Energy consumption is about 14 watts per solenoid.

Two electrically independent solenoids operate two lever-action valves. Device will handle heavy oils and steam up to 125 pounds pressure

Wrinkle Enamels Produced in Colors

WRINKLE enamels in every color, including white and light pastel shades, have been developed by Maas and Waldstein Co., 438 Riverside avenue, Newark, N. J. Practically no discoloration occurs during baking of these finishes. Another improvement claimed by the manufacturer is that Duart wrinkle enamel bakes hard and resistant to wear with a short baking schedule. The product is light in body and can be sprayed like synthetic enamel. Patterns can be varied from a fine and uniform to a coarse and heavy structure. Only one coat is needed.

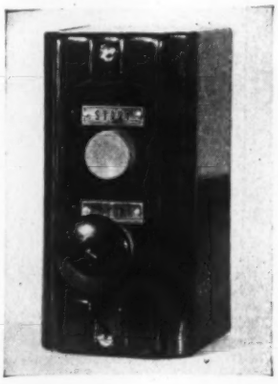
New Linestarters Are Announced

"DE-ION" linestarters for alternating current motors up to 5 horsepower, 220 volts, and 7½ horsepower, 440 to 550 volts have been placed on the

(*Continued on Page* 69)

(*Continued from Page* 66)

market by Westinghouse Electric & Mfg. Co., East Pittsburgh. They are housed in an oversize cabinet, providing an unusually large amount of wiring space.



Starters are housed in oversize cabinet, giving an unusually large amount of wiring space

Starters may be obtained with separate pushbutton, with built-in, start-stop pushbutton, or with built-in hand-off automatic switch.

A.C. Motors Have Variable Speed

PERMANENT split phase motors for alternating current for use with such equipment as ventilating and circulating fans where a variation in speed is required, have been developed by Reynolds Electric Co., 2650 West Congress street, Chicago. This type of motor is essentially a shaded pole design, the shaded pole winding producing a split field and permitting subsynchronous operation. To obtain speed variation the applied voltage is varied by means of a rheostat. The motors have a rather low starting torque, relatively efficient full load characteristics and high breakdown torque, and are built in sizes ranging from 1/20 to 1/6 horsepower.

To obtain speed variation in motor, the applied voltage is varied by means of simple rheostat

Thermostat Has Many Uses

THERMOSTAT, known as the two-stage sensatherm, especially suitable for room temperature control on high-low fire gas or oil burners has been brought out by The Mercoid Corp., 4201 Belmont avenue, Chicago. It is also a desirable control for eliminating overshooting temperatures on stokers with forced circulating warm air systems and for

POSITIVE AIR CONTROL

increases

efficiency

Economical use of air power and smooth, easy handling of air operated equipment results from the simple, perfected disc-type design of Hannifin "Packless" Air Control Valves. These valves have no packing, and no leakage or packing maintenance troubles. The bronze disc is ground and lapped to form a perfect seal with the seat, which is similarly finished. Simply re-lapping restores the original efficient seal after long service.

Hannifin Air Control Valves are made in 3-way and 4-way types, hand and foot operated, spring return, heavy duty rotary, manifold, and electric remote control models, for control of all types of air or hydraulic equipment. Write for Valve Bulletin 34-MD.

●

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Engineers • Designers • Manufacturers
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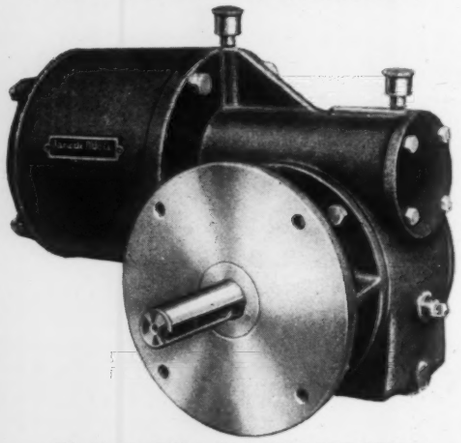
HANNIFIN "Packless" AIR CONTROL VALVES

Janette
MOTORIZED SPEED REDUCERS

16 DIFFERENT STYLES
From which to select the type of drive that exactly meets YOUR INDIVIDUAL REQUIREMENTS.



Illustrating RW-1 FLANGE REDUCER
The diversity of the Janette custom built line of motorized speed reducers enables us to supply a machine for almost any purpose. Let our engineers help in selecting the right type for your application.

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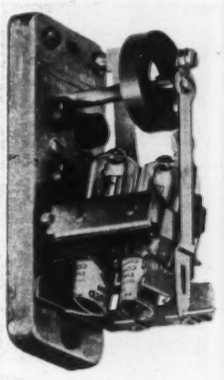
—such as these, and numerous others, are the logical product of a skilled organization with a deft 'feel' for *precise* work. . . . Note the *Combination* Worm-gear, rotating as a Gear on one side and as a Worm on the opposite side.

Made to order *only*—No stock—No catalog

Gear Specialties
INCORPORATED
CHICAGO

the regulation of two-speed fans on air conditioning systems. The two-stage sensatherm is equipped with two dustproof sealed mercury contact switches, operated by means of one bimetal coil and two permanent magnets. Maximum capacity of each circuit of this instrument is 9/10 ampere at 24 volts or less.



Two-stage sensatherm is equipped with two dustproof mercury contact switches, operated by one bimetal coil and two permanent magnets

Pivoted Motors Assure Belt Tension

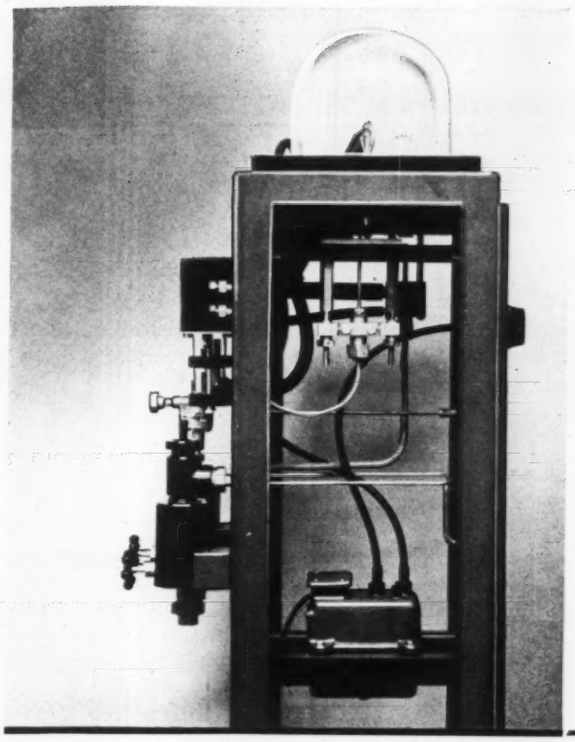
DESIGNED especially for short center V or flat belt drives, a pivoted motor has been brought out by Burke Electric Co., Erie, Pa. The motor, construction of which is standard, automatically keeps the belt in tension in proportion to the load and takes care of normal belt elongation without manual adjustment. A pivot, mounted in bronze bushings, is used for attaching the motor to the base. All types of Burke motors and generators, including synchronous and direct current motors, can be pivotally mounted.

Part holding pivoted motor to base is mounted in bronze bushings giving long wear

Meetings and Expositions

Aug. 9-12—

American Institute of Electrical Engineers. Annual Pacific coast convention to be held at Multnomah hotel,

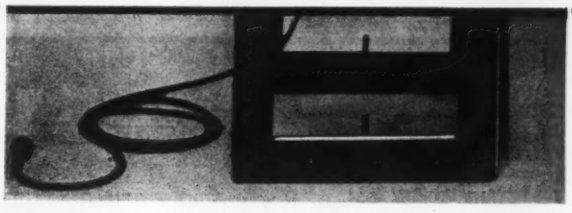


THE MACHINE illustrated, a product of Wallace & Tiernan Co., Inc. of Newark, N. J., is used for chlorinating municipal water supply.

Two S. S. WHITE flexible shafts are used—one for driving the rotating meter at the upper left, which regulates the flow of chlorine—the other for adjusting the output speed of the driving motor and speed reducing mechanism in the center.

"We have used flexible shafts," says the manufacturer, *"because they simplify the mechanics of the machine and eliminate several otherwise necessary parts."*

Another good example of the advantages of FLEXIBLE SHAFTS in machine design



Photograph, courtesy of Wallace & Tiernan Co., Inc. Newark, N. J.

Only a moment's consideration of the illustration is needed to appreciate the extreme simplicity with which the self-contained, easily applied flexible shaft units solve the problem of remote control or power transmission. Obvious also is the fact that flexible shafts facilitate design, because they make it possible to place parts in the most desirable locations.

HAVE YOU SENT FOR YOUR COPY OF ENGINEERING BULLETIN 38?

It gives full information and engineering data about Flexible Shafts for Remote Controls and how to apply them. A request on your business letterhead will bring you a free copy.

Bear these flexible shaft advantages in mind when you design. We'll be glad to recommend the proper shafts for specific requirements and to cooperate in working out application details. No obligation. Just send us essential data.

S. S. WHITE

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